First Semi-Annual Report
AFDC Light Duty Vehicles

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Section 1.0 Introduction

This report is produced in partial fulfillment of the subcontract with the Office of Transportation Technologies of the U.S. Department of Energy. The Alternative Motor Fuels Act of 1988 (AMFA) programs are divided into two phases, AMFA I and AMFA II. The AMFA I program began in January 1991 with the introduction of 65 M85 alternative fuel vehicles (25 1991 variable fuel Chevrolet Luminas and 40 1991 flexible fuel Ford Tauruses) and 16 control vehicles (8 1991 standard production Lumina and 8 1991 standard production Tauruses) at four locations in the United States: Detroit, MI; Los Angeles, CA; San Diego, CA; and Washington, DC. The Alternative Fuels Data Center (AFDC) also has information in its database tables on the AMFA II sites (introduced in 1992) of Argonne, IL (5 E85 1993 Chevrolet Luminas, 5 CNG Dodge RAM Vans, 4 CNG Chevrolet C-2500 pickups, 1 1993 Chevrolet Lumina standard control vehicle); Bakersfield, CA (20 CNG Dodge Ram Vans); and El Paso, TX (48 CNG Chevrolet C-2500 pickups). See Table 1-1. In the overall program, more than 2.06 million miles have been logged by the 163 vehicles on which data have been received for more than 1.90 million miles (92.2%). Data are just beginning to be received from other AMFA II locations at Denver, Houston, New York, and additional vehicles at Washington, DC, and Detroit. These latest data are not included in this report.

This is the first report from the AFDC that analyzes and interprets the data that are stored and accessible to the public. This analytical report will be updated every six months. Beginning with the next semi-annual report (April 1, 1994), the data will be compared to the previous report, noting any significant changes in trends in any of the reporting categories.

1.1 Scope

This report is divided into four analysis sections:

- Section 2- Program Monitoring and Data Quality Assessment
- Section 3 - Fuel Economy Analysis
- Section 4 - Performance and Unscheduled Maintenance Analysis
- Section 5 - Emissions Analysis
- Section 6 - Future Considerations

This report will analyze all AMFA light-duty fleet vehicles in the AMFA I and AMFA II programs. In these programs, there are currently seven sites that have contributed data to the AFDC data base tables. There are still several areas of data from these sites that have not yet been received, but that will be received in time for the next analysis. These data include information on gasoline control Dodge Ram vans at Bakerfield and gasoline control Chevrolet pickups at El Paso. These vehicles are on site and we should begin receiving data in the next month. Also, at these two sites, no maintenance data on any of the vehicles has been received yet. Efforts are now under way to obtain this data.

The AFDC has begun to receive used lube oil analysis data and analysis of fuel sampled directly from dispensers. However, the data only cover a few months and were not considered complete enough to report on here. One last area is speciated emissions data, which have been measured on several of the dynamometer tests conducted over the last two years. These data have been received by the data center, but are not yet in a format to facilitate an engineering analysis. These data will be included in the next analysis report.

The sites and number of vehicles by vehicle type for vehicles currently in the AMFA program are presented in Table 1-1. Overall, there are 163 vehicles on which data are currently being collected and that have been entered into the AFDC. Of these 163 vehicles, 24 are M85 control vehicles. The remaining 139 are those expected to run on the alternative fuel for which the vehicles were designed. Data for Argonne exist some of the program vehicles (14 currently in the database). A total of 31 vehicles at Argonne will be reporting data (5 E85, 9 CNG, 16 M85, 1 control) to the AFDC in the near future.

1.2 Analysis Highlights

1.2.1 Program Monitoring and Data Quality Assessment

- More than 2 million miles of data have been logged into the AFDC by the 163 reporting AMFA vehicles.
- Detailed mileage data have been received on 92.2% of all miles accumulated.
- All the AMFA vehicles are accumulating, on the average, 786 miles per month. The San Diego and Los Angeles vehicles have averaged almost 1,000 miles per month per vehicle for the more than 2 years the vehicles have been in the program.
- Vehicles are used on about two-thirds of the days they are available for use.
- Methanol (M85) was the refuel choice for about five-sixths of the gallons consumed in M85 alternative fuel vehicles.
- Improvements in data reporting are needed, especially for refueling and maintenance information.

1.2.2 Fuel Economy Analysis

- The average in-use fuel economy for CNG Dodge RAN Vans operating near Bakersfield was determined to be 10.1 miles per an equivalent gallon of gasoline..•
- The average in-use fuel economy for CNG Chevrolet C-2500 pick-up trucks operating near El Paso was determined to be 13.5 miles per equivalent gallon of gasoline. The

results of three dynamometer FTP (city cycle) tests showed 11.8 miles/eq. gallon and one HWFET (highway cycle) test showed 17.8 miles/eq. gallon.

- A detailed evaluation of the in-use fuel economy of Taurus FFVs and Lumina VFVs operating on M85 only shows values of 11.2 to 15.6 mpg (miles per actual gallon of M85) depending on the use pattern. Dynamometer results averaged 11.4 mpg during the FTP (city cycle) and 19.7 during the HWFET (highway cycle).

1.2.3 Performance and Unscheduled Maintenance Analysis

- Currently, driver-reported performance problems are typically less than 1 per 10,000 miles of operation.

- CNG vehicles at El Paso initially experienced a higher incidence of performance problems, which has been corrected by installation of an improved injector.

- Methanol vehicle maintenance initially was needed about every 5,000 miles on emission controls, wiring, pumps, fuel injection systems, and sensors.

- Specific long-term maintenance items for methanol vehicles cannot be determined yet because of insufficient data.

- CNG maintenance data are not yet available.

- Methanol vehicles may require maintenance about twice as often as stock vehicles, although data are inadequate to provide statistical certainty.

1.2.4 Emissions Measurements

- In general, all the regulated exhaust emissions showed increases with vehicle mileage.

- The emissions-exempt 1991 FFV Tauruses had generally poorer emissions than standard production 1991 Tauruses.

- Although the FFV Tauruses showed higher CO emissions (exceeding the EPA limits) than the production Tauruses, the FFV showed lower emissions when using M85 than when using indolene.

- Lumina VFVs had lower CO emissions than standard Luminas while operating on indolene, but had higher CO emissions when using M85.

- NO_x emissions for all vehicles were less than the EPA limit.

- The VFV Luminas showed less THC than the production Luminas when burning indolene. Further, the VFVs had even lower OMHCE (THC for alcohol fuels) when operating on M85.

- The production Tauruses had very low THC emissions; the FFV Tauruses were lower on M85 than on indolene.

Table 1-1. Summary of Vehicles Reporting Information

Site	All Vehicles	M85 Taurus	M85 Lumina	E85 Lumina	CNG Chev. Pickup	CNG Dodge Van
AR	14			5	4	5
BK	20					20
DC	21	14	7			
DT	18	14	4			
EL	48				48	
LA	9	4	5			
SD	9	4	5			
Sum - Alt Fuel Veh's	**139**	**36**	**21**	**5**	**52**	**25**
Site	**All Vehicles**	**M85 Taurus**	**M85 Lumina**	**E85 Lumina**	**CNG Chev. Pickup**	**CNG Dodge Van**
DC	6	3	3			
DT	6	3	3			
LA	6	3	3			
SD	6	3	3			
Sum - Controls	**24**	**12**	**12**			
Site	**All Vehicles**	**M85 Taurus**	**M85 Lumina**	**E85 Lumina**	**CNG Chev. Pickup**	**CNG Dodge Van**
AR	14			5	4	5
BK	20					20
DC	27	17	10			
DT	24	17	7			
EL	48				48	
LA	15	7	8			
SD	15	7	8			
All Vehicles	**163**	**48**	**33**	**5**	**52**	**25**

Section 2.0 Program Monitoring and Data Quality Assessment

The program monitoring and data quality assessment functions at the AFDC are aimed at providing front-line information for the program monitors and site coordinators in the field who are responsible for monitoring both the performance of the vehicles and the frequency with which information is reported on the vehicles.

This report contains analyses of summary information and presents individual vehicle data and the data collection assessment surrounding these vehicles. This section of the report will focus on how well the AMFA vehicles are reporting and accumulating data. The general areas of investigation with regard to program monitoring and data quality assessment functions follow:

- *Vehicle Mileage Accumulation.* The rate at which vehicles are accumulating mileage indicates how much data will be collected during the life of the vehicle, and may also indicate or predict consumer acceptance and available infrastructure. For example, low mileage accumulations may indicate that the vehicles are not performing well, or that an infrastructure for the particular alternative fuel is not available and/or is not convenient. Site management could also play a factor in the use and acceptance of alternative fuel vehicles.

- *Vehicular Use - Miles Per Day Driven.* The average number of miles that a vehicle is driven each day is another indicator of vehicular use. The distribution of the daily miles driven will be the subject examined here.

- *Vehicle Use - Proportion of Days Used.* This section will examine the question of the proportion of days vehicles are being used out of the total possible number of days that they could be in service. Vehicles driven 200-300 miles per day, but only driven twice a week, for example, have a duty cycle much different from vehicles driven the same mileage, but in use most every day of the week.

- *Refueling Analysis.* A refueling index, representing the proportion of alternative fuel actually being used by the alternative fuel vehicles, has been compiled and will be discussed.

- *Unscheduled Maintenance.* This analysis will center on driver-reported unscheduled maintenance occurrences (DRUMO) versus repair shop unscheduled maintenance occurrences (RSUMO).

2.1 Vehicle Mileage Accumulation

For purposes of analyzing the data and therefore the percentage of miles on which vehicles have reported information, accumulated miles are calculated by computing the difference between the odometer when the vehicle first reported data to the program, and the current, or maximum, odometer reading. The mileage on which information has been reported by the vehicles is computed by calculating the sum of the total daily ending minus beginning odometer readings for each vehicle. Some of the factors that may affect the reporting process include:

- How well the site coordinators are trained and buy into the program
- How often they are reminded of the job they are doing and the importance of their efforts to the program
- How well the data sheets are reviewed and transferred to the AFDC by the subcontracting agency, fleet managers, and drivers
- How well the individual drivers are monitored by the site coordinators
- Whether or not the vehicles are in a motor pool or assigned to individual drivers. Vehicles assigned to individuals will have a better chance of having the data logged for the vehicle in a timely and reliable fashion
- With regard to refueling information, if vehicles are taken by a motor pool for refueling, reporting of refueling for each vehicle will tend to be less accurate than if individual drivers are responsible for their own refueling.

Data on the vehicles are received on weekly log sheets that contain entries for daily information, such as vehicle mileage. Refueling information is logged when fuel is added to the vehicle, and sections are also available to comment on vehicle performance, lubrication oil additions, and whether scheduled or unscheduled maintenance has been performed. It should be noted that weekly log sheets may be received, but their receipt does not mean that they are complete. Refueling information in particular may have been inadvertently omitted, for example.

Figure 2-1 presents a summary of miles accumulated for the AMFA sites, as well as an indication of the reporting tenacity at each of the sites. In viewing Figure 2-1, we see that Washington, DC has the poorest reporting record in terms of the proportion of miles for which records (weekly log sheets) have been received. More than 65,000 miles, or more than one-fifth of the total possible miles on which data could have been reported for Washington, DC, were not reported. (See Table 2-1 for the data on which the Figure 2-1 was built.) On the other hand, Argonne, in its infancy in the data reporting effort, has reported information on 100% of the vehicle use at its site. Of the four original AMFA I sites (Detroit; Los Angeles; San Diego; and Washington, DC), three have a reporting record of better than 92%, with San Diego at the top with 95.2% of the total possible miles reported.

As previously noted for the overall program, more than 2.06 million miles have been logged by the 163 vehicles, on which data have been received for more than 1.90 million miles

(92.2%). The site of Detroit has accumulated more than a half a million miles on its 24 vehicles. Appendix Figures A.2-1 to A.2-6 show the individual vehicle mileage reporting records by site. Of vehicles reporting less than 75% of the total possible miles on which data could be reported, Washington, DC, has 13; Detroit has 1; and El Paso has 1.Figures A.2-7 to A.2-14 provide tab charts which show individual vehicle weekly log sheet reporting data.

2.2 Vehicular Use - Miles Accumulated and Miles Driven per Month

To some degree, the miles accumulated by alternative fuel vehicles (AFV) may reflect the acceptance of the vehicles, or, perhaps, where vehicle mileage accumulation is low, the inconvenience of the refueling infrastructure. In some cases, the general purpose of the vehicle's use may be the cause of low mileage accumulation. Here, route characterization and some indication of the duty cycle of the vehicle is important. Figure 2-2 shows the mileage accumulated per vehicle by site for all the vehicles in the program. Of the four original AMFA sites, Washington, DC, the site poorest in reporting information, is also, by far, the site that has accumulated the lowest number of miles per vehicle (11,722). This number is well less than half that of Los Angeles (26,903) and San Diego (27,181). Refer to Table 2-1 for these numbers. Among other factors, the refueling infrastructure may lead to the significantly higher mileage accumulations in the Los Angeles and San Diego areas, where multiple refueling sites exist for M85. It is interesting to note, however, that, in spite of the greater abundance of refueling sites in the Los Angeles and San Diego areas, the tendency is not to refuel with M85 as often as the vehicles in Washington, DC, for example. (See the analysis below on *Refueling*.)

Figure 2-3 provides a better comparison of anticipated mileage accumulations over the life of the vehicles in the program. Examined here are the miles accumulated per vehicle each month for each site. Bakersfield vehicles, now in service almost 1 year each on the average (see Appendix tables A.2-1 to A.2-7 for individual vehicle data), are accumulating mileage at the rate of almost 1,200 miles per month. A small proportion of the vehicles in the AMFA I program will have more than 30,000 miles accumulated at the pace of current mileage accumulation by the end of 3 years. Twelve of the 81 AMFA I vehicles have accumulated more than 30,000 miles to date, most of which have between 25 and 30 months in the program. The Washington, DC, vehicles are accumulating less than half the miles per month (519.4) compared to the Bakersfield vehicles (1184.6). San Diego and Los Angeles vehicles are accumulating slightly less than 1,000 miles per month.

2.3 Vehicular Use - Miles Driven Per Day

Figures 2-4 and 2-5 gives some idea of the duty cycle of the vehicles by vehicle type. These figures show the frequency of miles vehicles have driven on the days on which they have been driven (and have reported data). Each bar represents the proportion of trips that the vehicle of a particular category has driven in that mileage range. For example, almost 15 % of all vehicle trips (Figure 2-4) are in the 0-10 miles per day range on the days that the vehicles are driven.

Some differences in duty cycle between the CNG vehicles and the methanol vehicles are noted in Figure 2-4. More than a quarter of the CNG vehicles average between 41 and 60 miles per day, whereas slightly more than one-sixth of the alternative fuel M85 vehicles average mileage in this range. Almost none (0.5%) of the CNG vehicles average more than 140 miles per day, whereas almost 1 in 11 (8.8%) of the M85 vehicles travel more than 140 miles per day. The most notable factor in Figure 2-5 is that about one-sixth of the daily trips taken by M85 Ford Tauruses tend to be 10 miles or less per day, whereas less than 10% of the GM Luminas were driven on trips of 10 miles or less per day.

2.4 Vehicle Use - Proportion of Days Used

Previously, the proportion of miles reported in the program has been analyzed. Now, the data have been derived to compute the percentage of days actually driven versus the number of possible days the vehicles could be driven. Some ground rules have been assigned to arrive at this analysis. The methodology consists of the following steps:

1. For each vehicle, sum the number of days on which the vehicle has been driven according to the weekly log sheet.

2. Now, divide this number by the proportion of mileage records reported. This yields a close approximation of the number of days the vehicle has been driven in the program, had all records been reported.

3. Determine the number of days the vehicle has been in the program from its first day of reporting information, to the latest report of information. Compute the number of days that the vehicle would be driven under ideal conditions (250 days per year was assumed) based on the total number of days the vehicle has been in the program.

4. Divide the results of step 2 (the number of days driven) by the results of step 3 (the optimum number of days the vehicle would be driven); the result is the proportion of days the vehicle is driven during the course of being in the program.

5. Accumulate these results into the various categories presented in Figures 2-6 to 2-8.

Figure 2-6 shows that all vehicles at all sites were driven on approximately two-thirds of the days that they could have been driven. The Bakersfield vehicles were used on almost 90% of the days, whereas Washington, DC, vehicles have been used on a little more than half the days (53.1%). In Figure 2-7, it is not surprising to find that the CNG vehicles, especially because of the Bakersfield and El Paso sites, were driven on about five out of every six driving days. The alternative fuel M85 vehicles are driven about 60% of the days on which they can be driven. Figure 2-8 further substantiates the data in the previous two figures by demonstrating the high proportion of days on which the CNG vehicles are being driven. Table 2-2 provides the supporting data for the above analysis.

2.5 Refueling Analysis

With regard to the M85 alternative fuel vehicles, which are supposed to attempt to run on M85 fuel to the maximum extent feasible, Figure 2-9 demonstrates that the Detroit vehicles have the best refueling records in that these vehicles have used M85 94.7% of the time when refueling. The Los Angeles and San Diego sites have used about 75% M85 in all their combined refuelings. Washington, DC, with the lowest proportion of records reported, has used M85 almost 90% of the time when refueling. Figure 2-10 shows the number of reported gallons of M85 consumed in the total program to date at almost 40,000 gallons. These numbers are probably at least 10% low because of non-reporting of data. (Information was only reported on 92% of the miles driven, and it is known that refuelings are missing from many of the records because of fuel economy computed between reported refuelings.) Table 2-3 provides the numbers from which Figure 2-10 was generated.

2.6 Unscheduled Maintenance

Figure 2-11 provides some insight between DRUMO and RSUMO (as defined on page 2-1). This figure represents the proportion of DRUMO compared to the RSUMO. It would generally be expected that the driver reports, DRUMO, would not be as high in frequency as the RSUMO. The number shown in Figure 2-11 for San Diego is disturbing. Here, it appears that the drivers are reporting unscheduled maintenance as having occurred in a much greater proportion (~1.5 times more) than the data that are being collected from the repair shops. If this is true, the maintenance information is not being forwarded from the maintenance shops, as is supposed to occur, or the vehicles are being taken to non-maintenance approved shops for unscheduled maintenance. Consequently, the repair records are not being received from these shops. As well, multiple repairs may be performed when a vehicle is taken into the shop. This would tend to inflate the shop repair order numbers relative to the driver reported numbers. In all probability, the reasons for the numbers represent a combination of several factors.

Overall, the proportion of DRUMO to RSUMO is (38.4%), with 304 DRUMO being reported and 791 RSUMO reported (see Table 2-4). Further analysis of these numbers is needed to derive how well the RSUMO match in time with the DRUMO and also to determine why there might be more DRUMO than RSUMO.

Figure 2-1

Accumulated and Reported Miles
By AMFA Site - 9/30/93

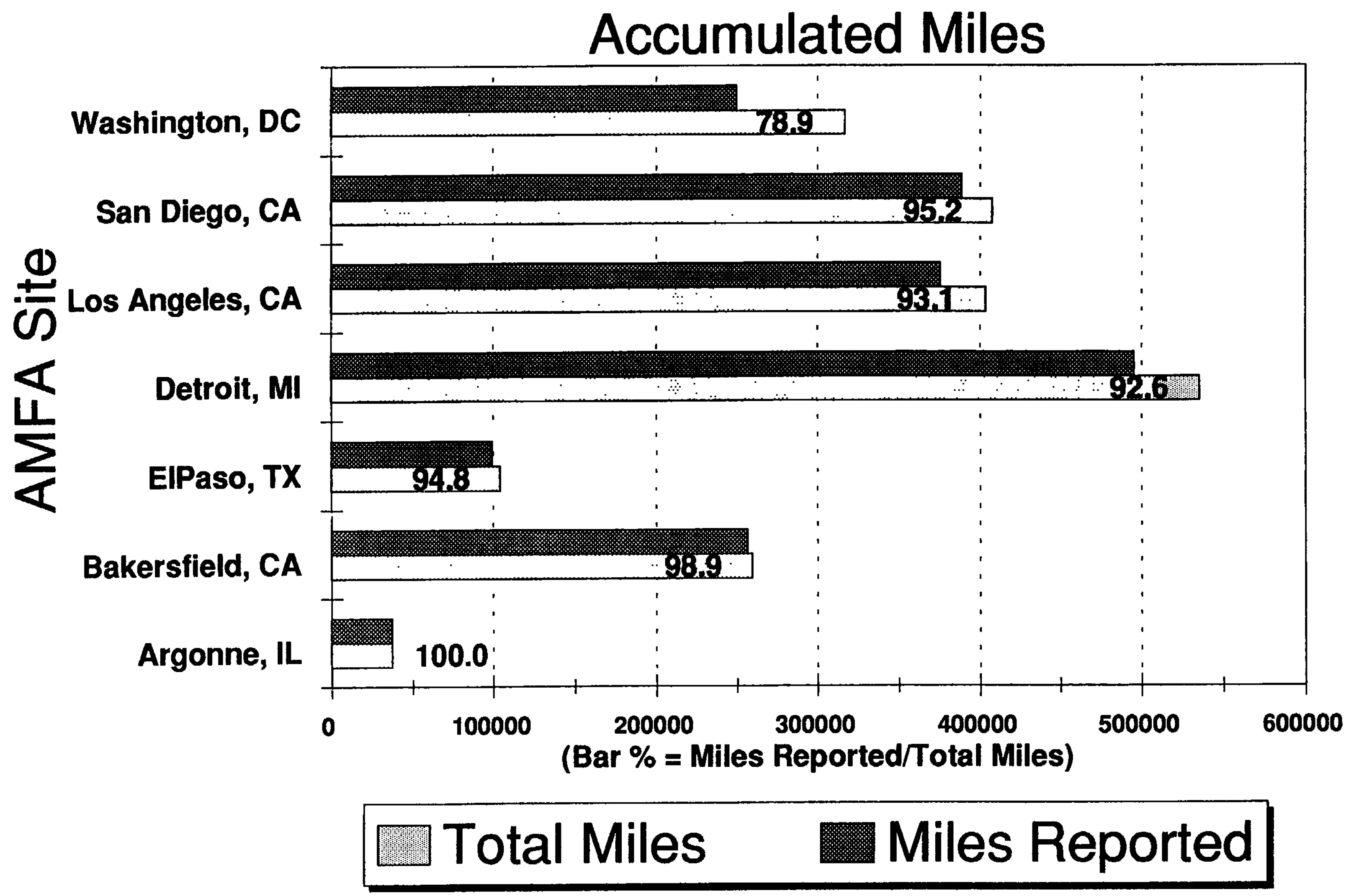


Figure 2-2

Miles Per Vehicle By Site
for AMFA Sites - 9/30/93

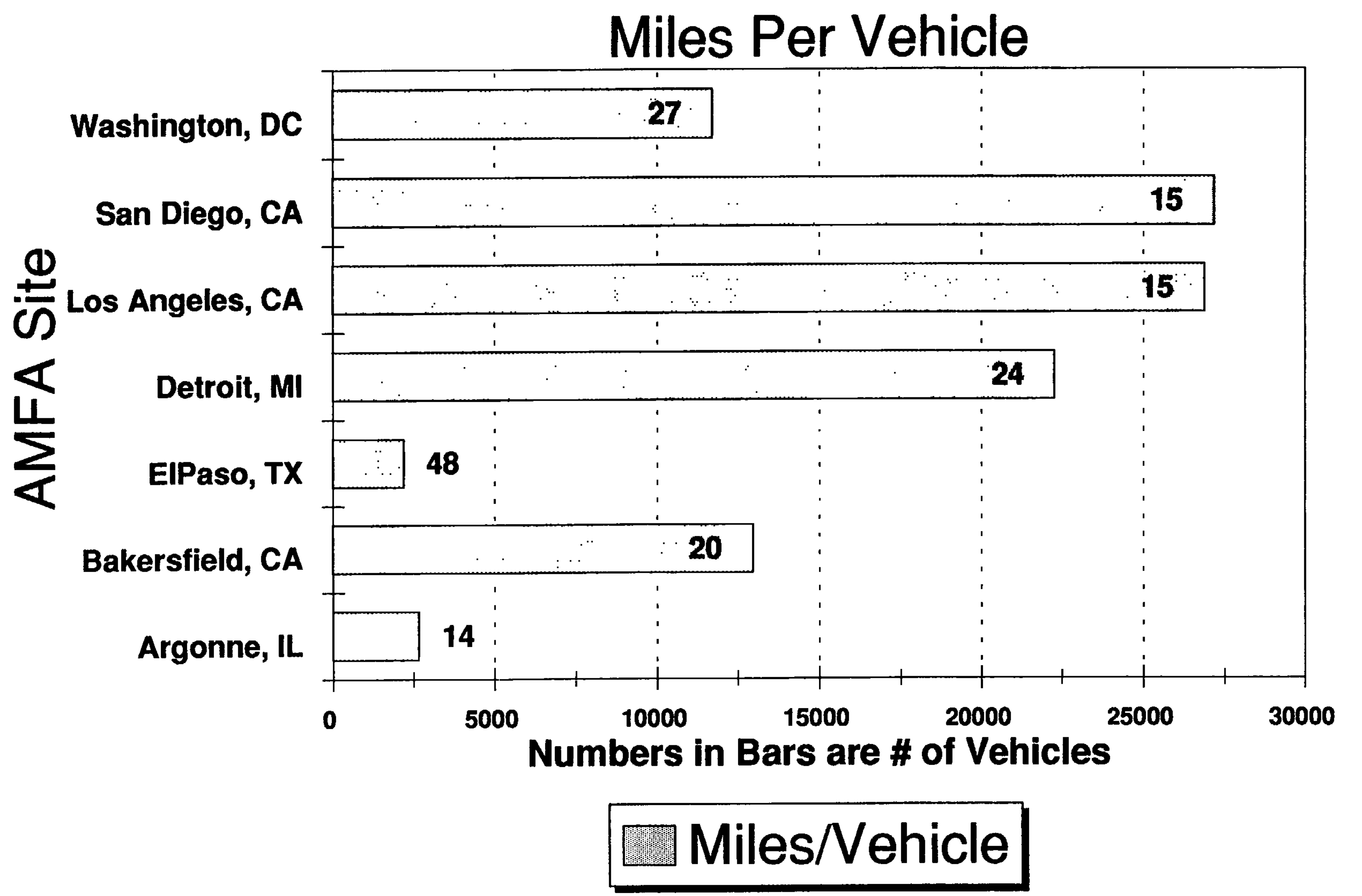


Figure 2-3

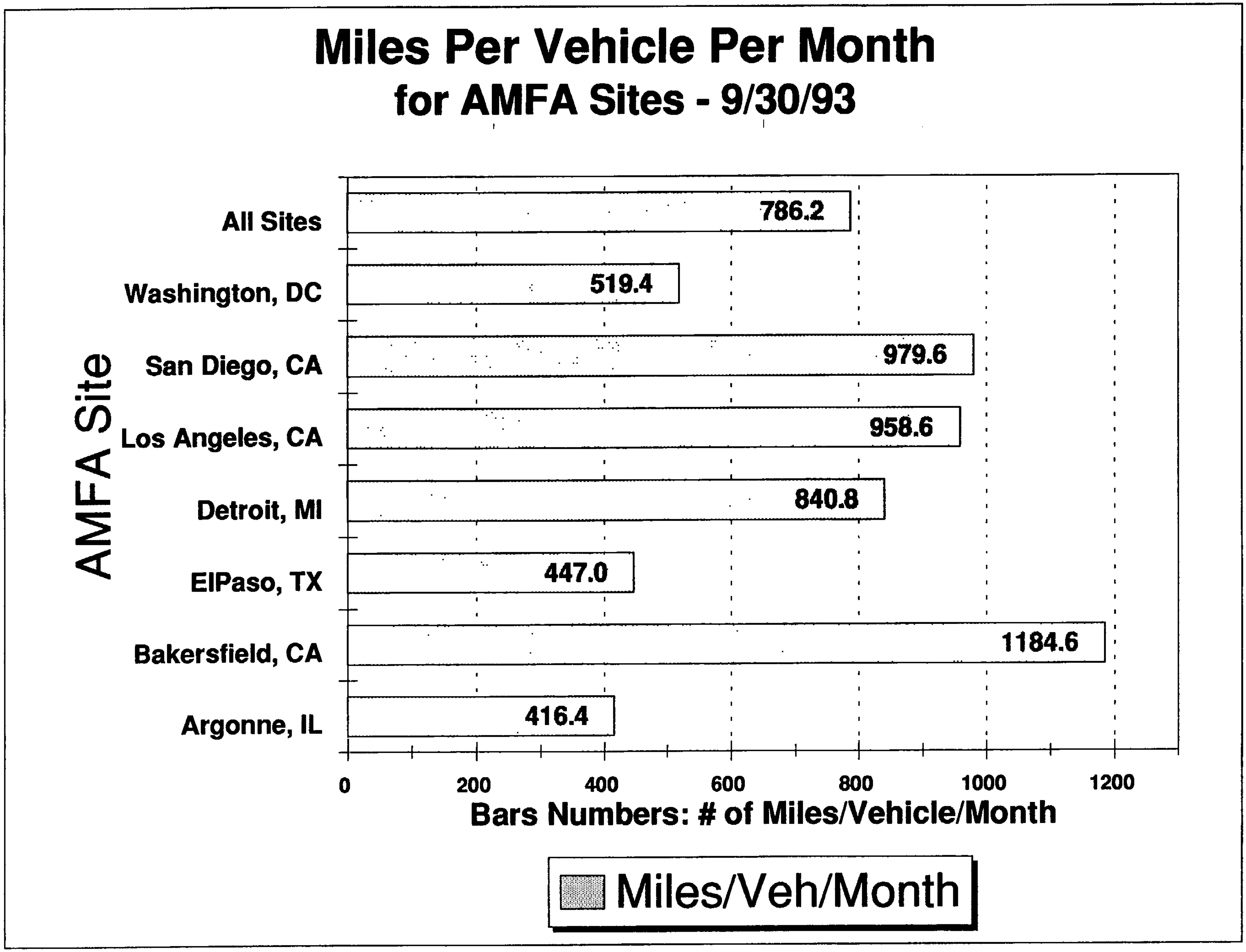
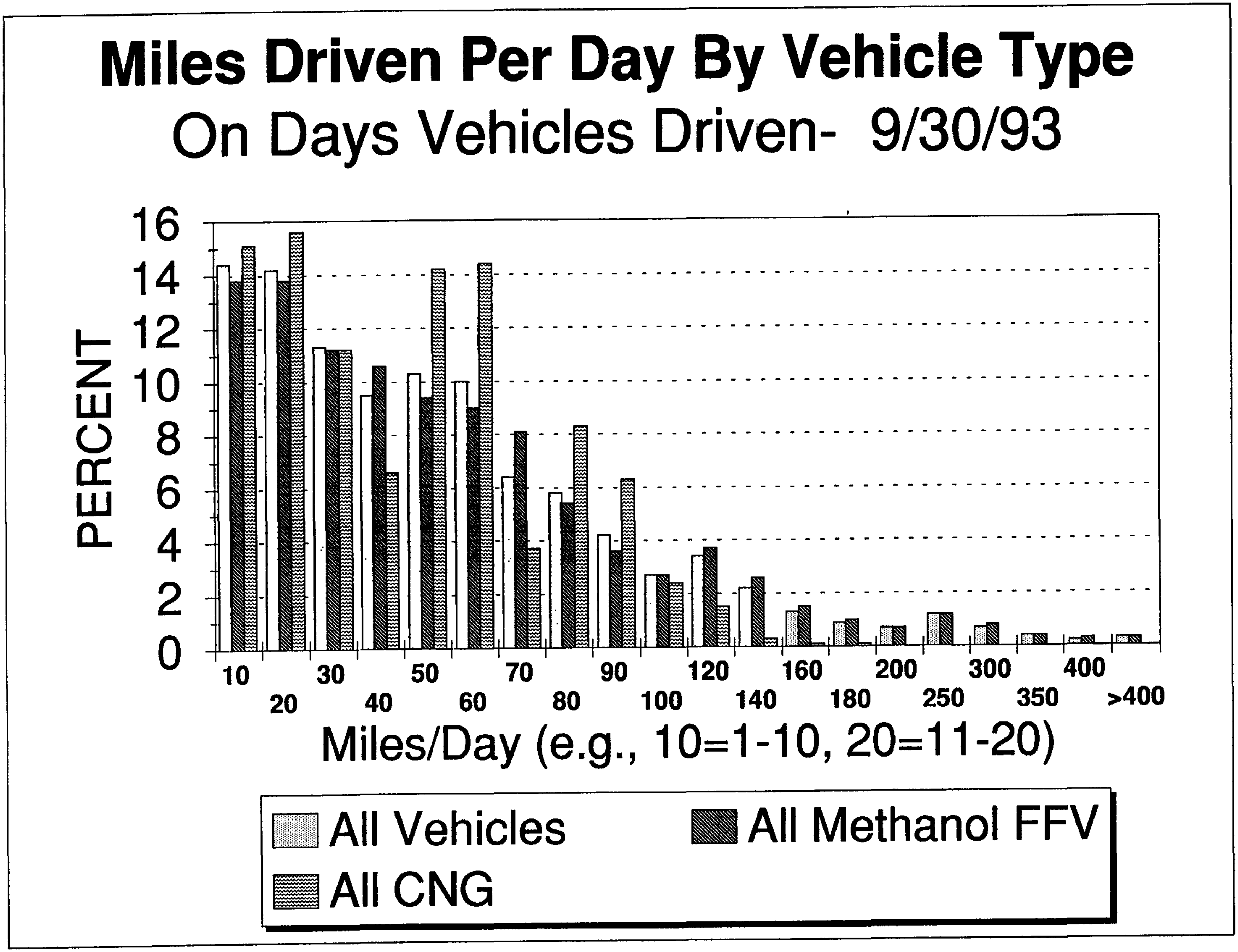
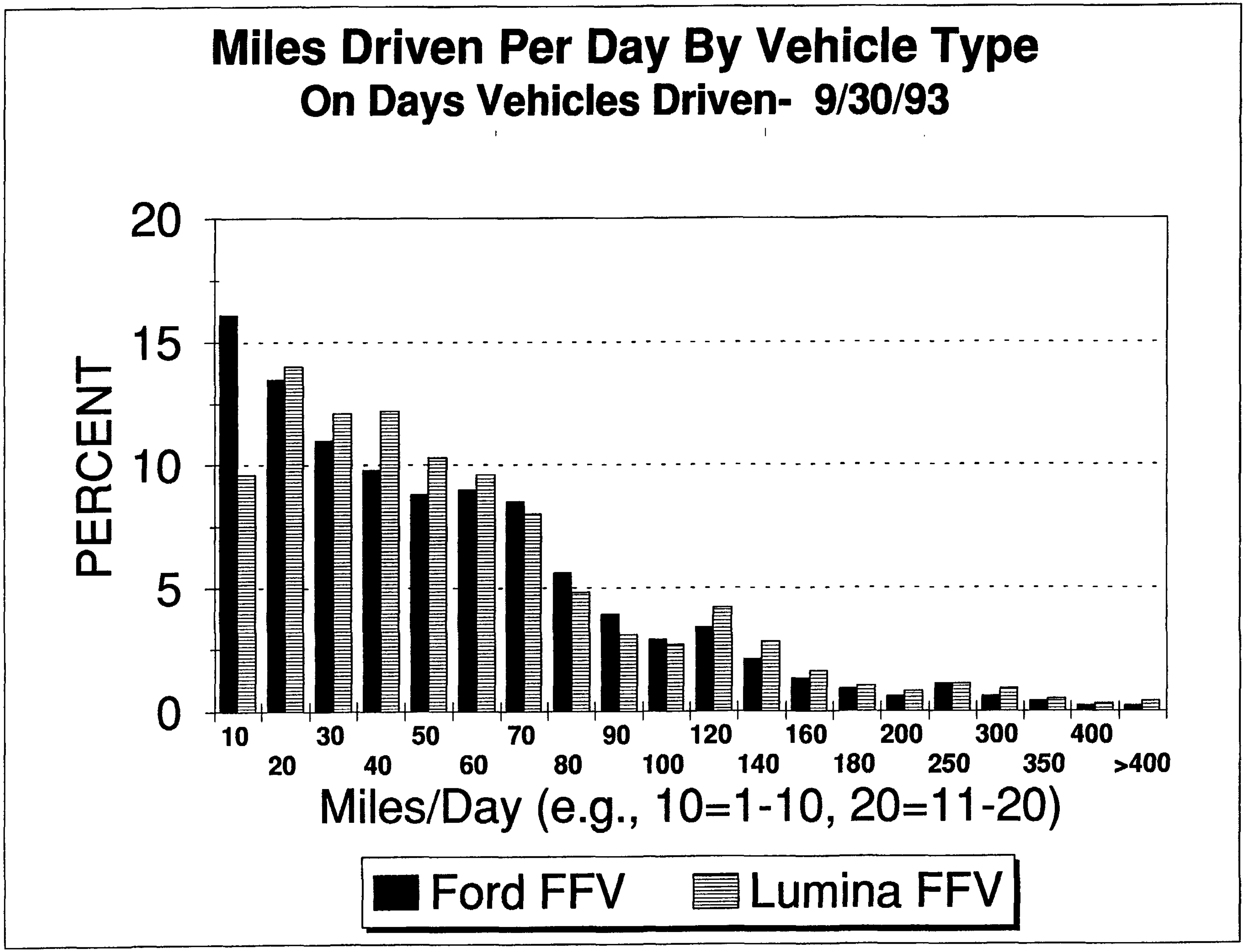

Miles Per Vehicle Per Month
for AMFA Sites - 9/30/93
AMFA Site
All Sites
Washington, DC
San Diego, CA
Los Angeles, CA
Detroit, MI
ElPaso, TX
Bakersfield, CA
Argonne, IL
786.2
519.4
979.6
958.6
840.8
447.0
1184.6
416.4
0
200
400
600
800
1000
1200
Bars Numbers: # of Miles/Vehicle/Month
Miles/Veh/Month

Figure 2-4



Miles Driven Per Day By Vehicle Type
On Days Vehicles Driven- 9/30/93
PERCENT
16
14
12
10
8
6
4
2
0
10
20
30
40
50
60
70
80
90
100
120
140
160
180
200
250
300
350
400
>400
Miles/Day (e.g., 10=1-10, 20=11-20)
All Vehicles
All Methanol FFV
All CNG

Figure 2-5



Miles Driven Per Day By Vehicle Type
On Days Vehicles Driven- 9/30/93
PERCENT
20
15
10
5
0
10
20
30
40
50
60
70
80
90
100
120
140
160
180
200
250
300
350
400
>400
Miles/Day (e.g., 10=1-10, 20=11-20)
Ford FFV
Lumina FFV

Figure 2-6

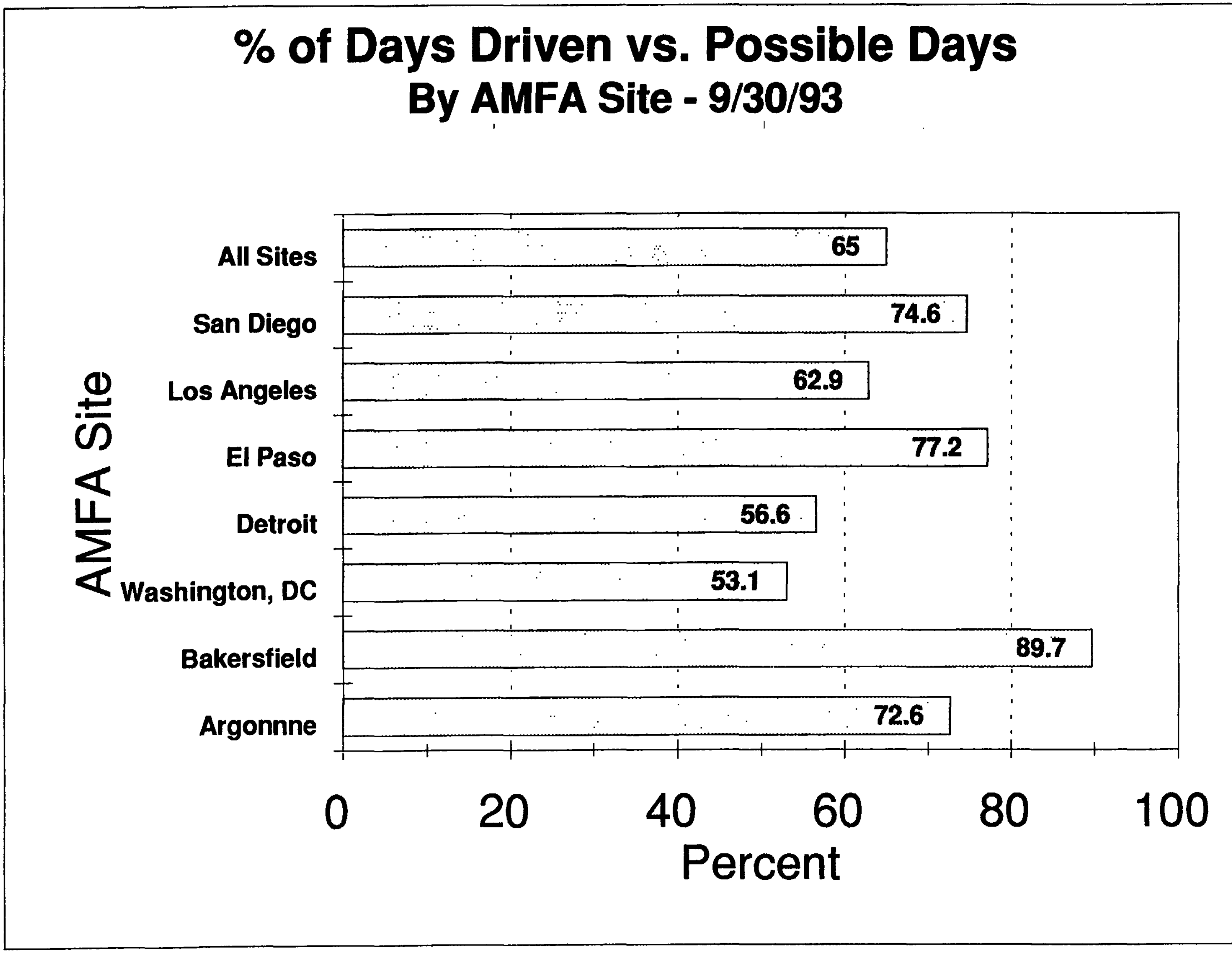

% of Days Driven vs. Possible Days
By AMFA Site - 9/30/93
AMFA Site
All Sites
San Diego
Los Angeles
El Paso
Detroit
Washington, DC
Bakersfield
Argonnne
65
74.6
62.9
77.2
56.6
53.1
89.7
72.6
0
20
40
60
80
100
Percent

Figure 2-7

% of Days Driven vs. Possible Days
By Vehicle Class - 9/30/93

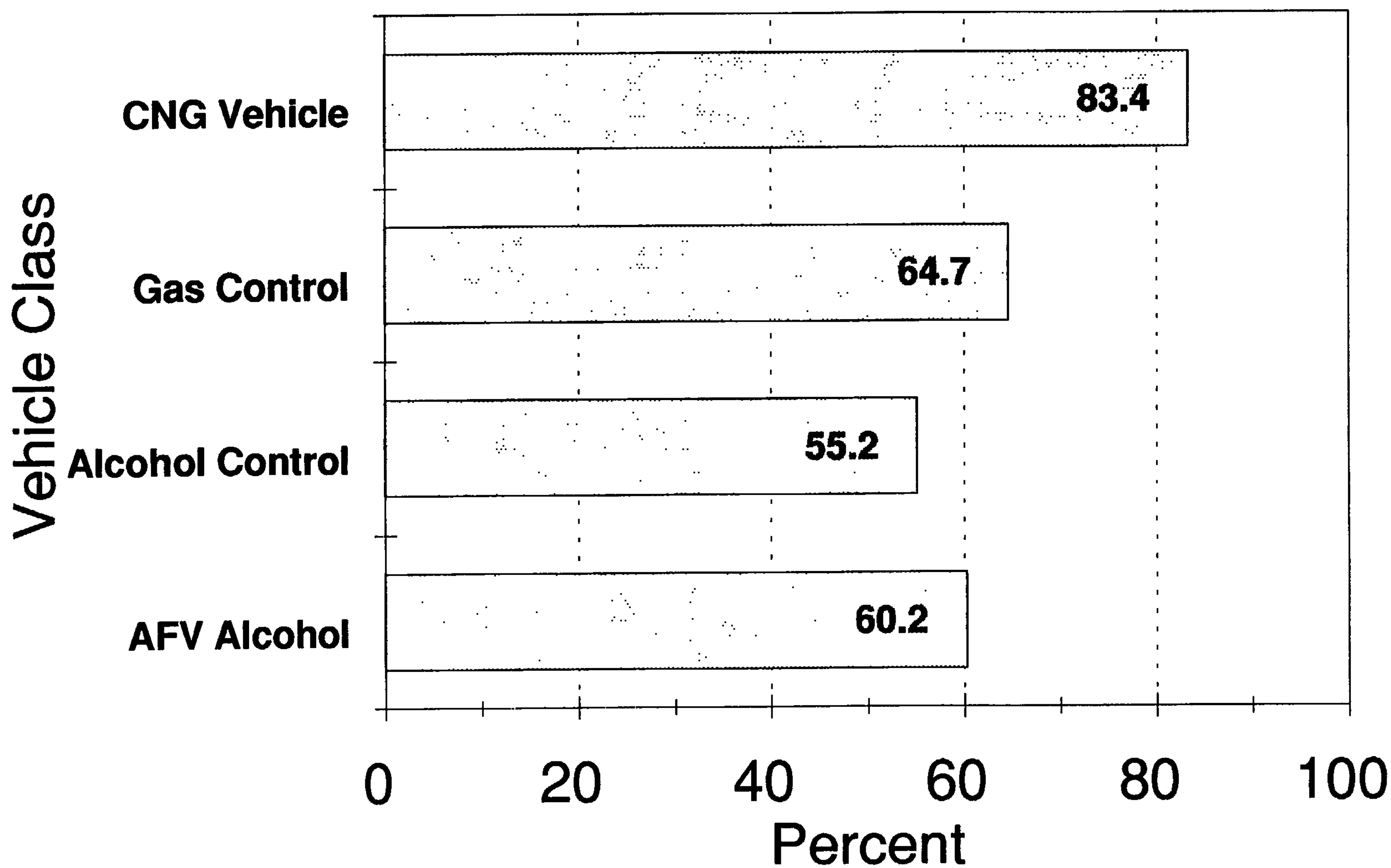


Figure 2-8

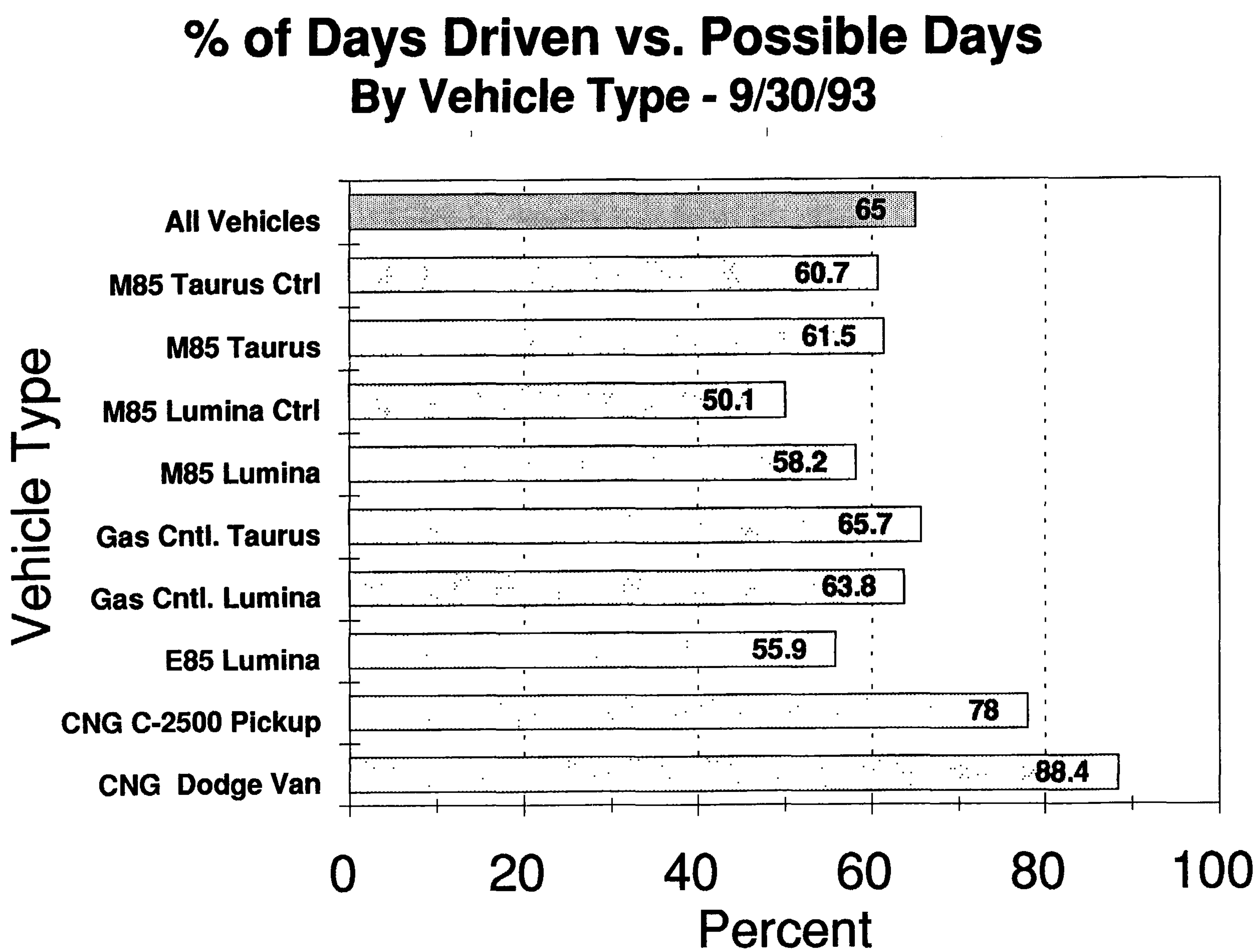
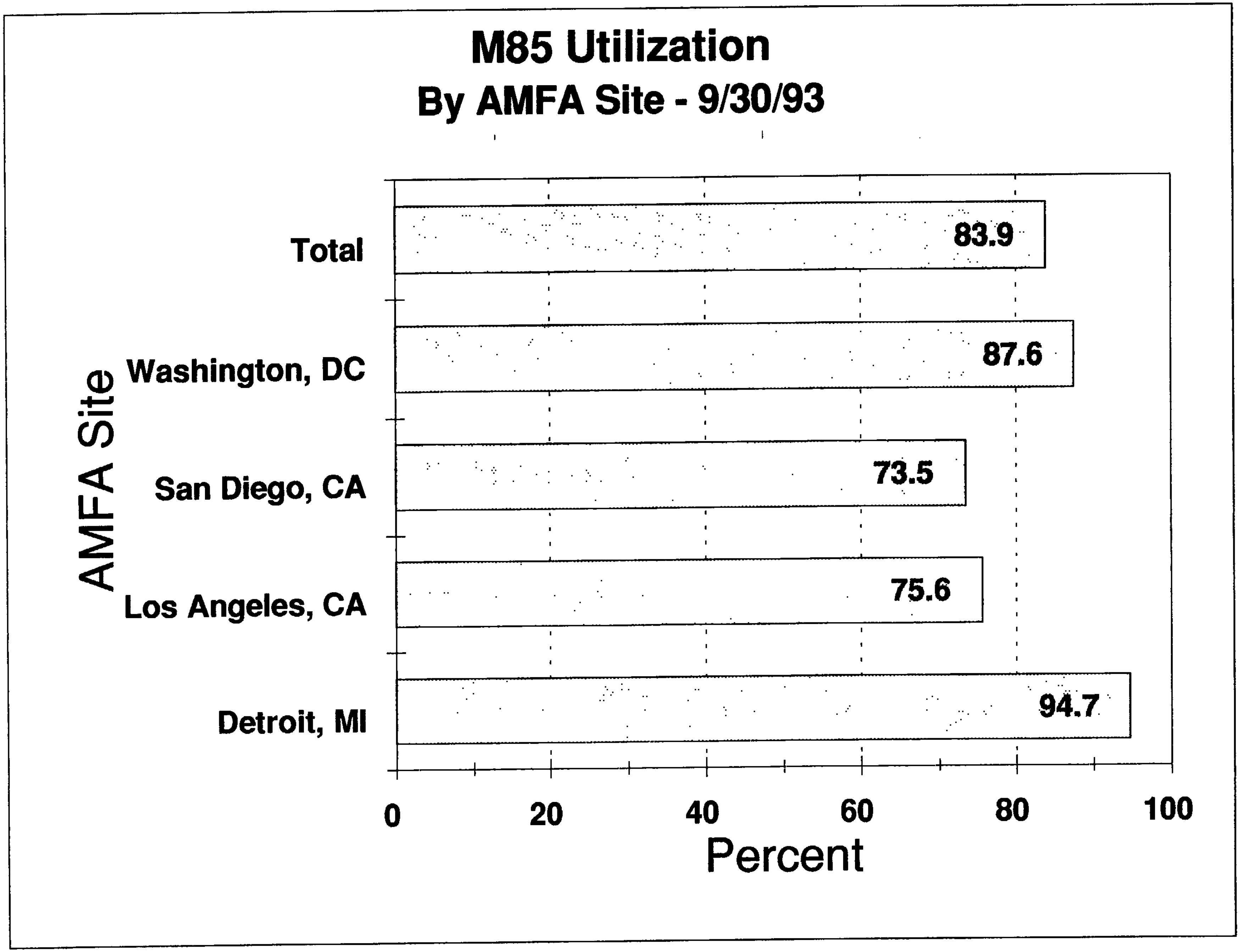

% of Days Driven vs. Possible Days
By Vehicle Type - 9/30/93
Vehicle Type
All Vehicles
M85 Taurus Ctrl
M85 Taurus
M85 Lumina Ctrl
M85 Lumina
Gas Cntl. Taurus
Gas Cntl. Lumina
E85 Lumina
CNG C-2500 Pickup
CNG Dodge Van
65
60.7
61.5
50.1
58.2
65.7
63.8
55.9
78
88.4
0
20
40
60
80
100
Percent

Figure 2-9



M85 Utilization
By AMFA Site - 9/30/93
AMFA Site
Total
Washington, DC
San Diego, CA
Los Angeles, CA
Detroit, MI
83.9
87.6
73.5
75.6
94.7
0
20
40
60
80
100
Percent

Figure 2-10

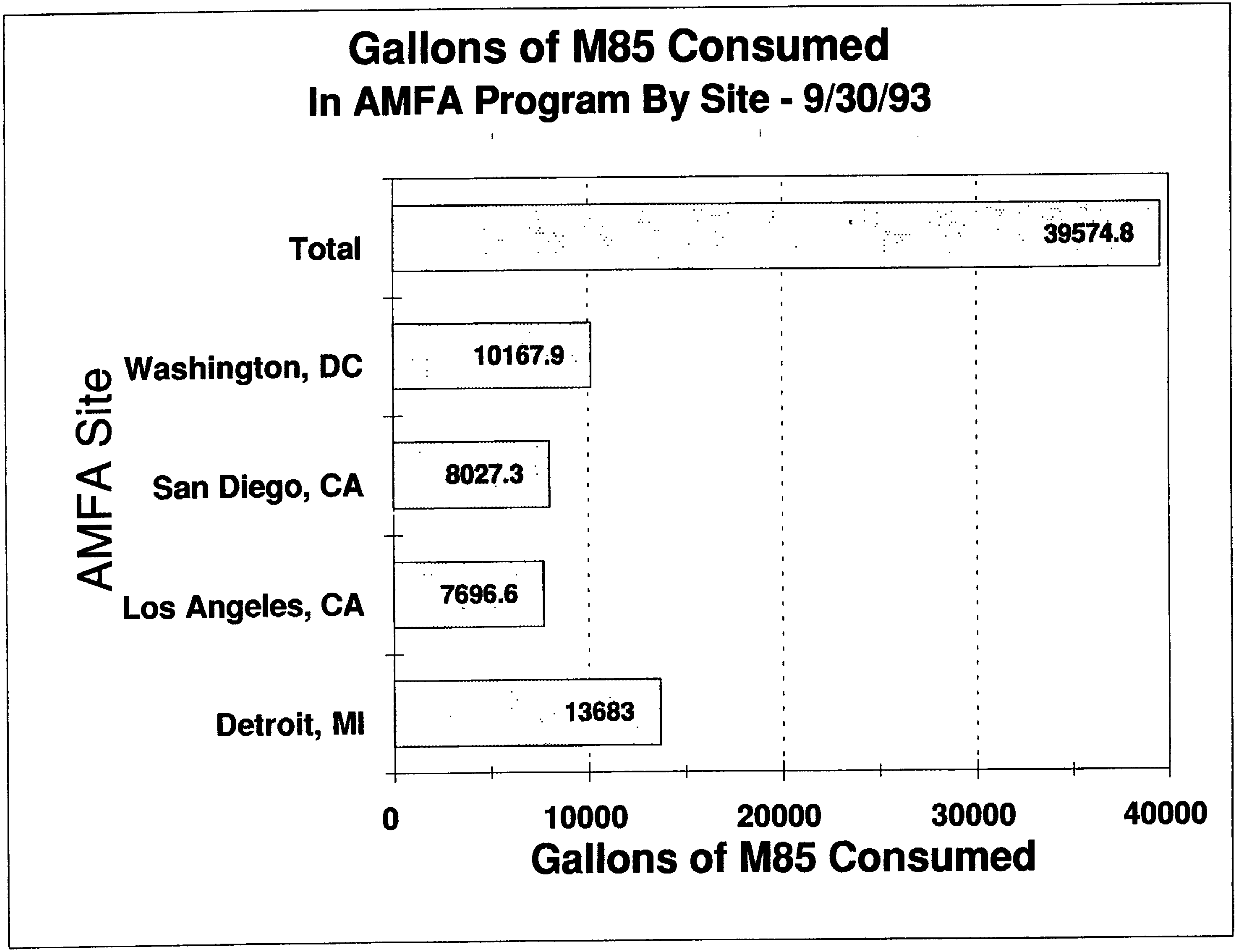
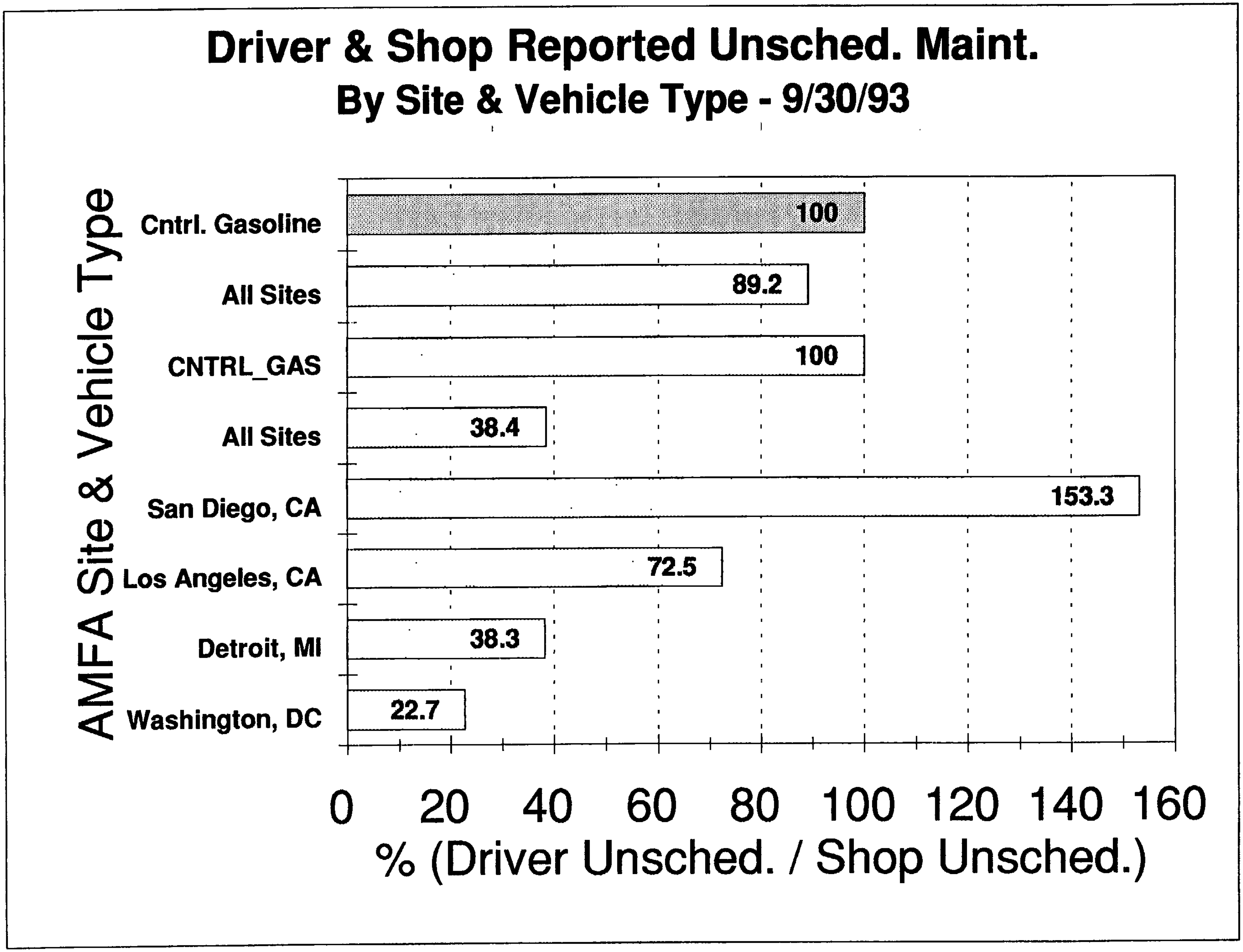

Gallons of M85 Consumed
In AMFA Program By Site - 9/30/93
AMFA Site
Total
Washington, DC
San Diego, CA
Los Angeles, CA
Detroit, MI
39574.8
10167.9
8027.3
7696.6
13683
0
10000
20000
30000
40000
Gallons of M85 Consumed

Figure 2-11



Driver & Shop Reported Unsched. Maint.
By Site & Vehicle Type - 9/30/93
AMFA Site & Vehicle Type
Cntrl. Gasoline
All Sites
CNTRL_GAS
All Sites
San Diego, CA
Los Angeles, CA
Detroit, MI
Washington, DC
100
89.2
100
38.4
153.3
72.5
38.3
22.7
0 20 40 60 80 100 120 140 160
% (Driver Unsched. / Shop Unsched.)

Table 2-1. Site Summary Service/Use Information

AMFA Site	Total Miles	Miles Reported	% Reported	No. of Vehicles	Miles/Vehicle	Months in Service	Miles/Veh/Month
Argonne, IL	37268	37268	100.0	14	2662	89.5	416.4
Bakersfield, CA	259419	256612	98.9	20	12971	219	1184.6
ElPaso, TX	104546	99139	94.8	48	2178	233.9	447.0
Detroit, MI	535058	495629	92.6	24	22294	636.4	840.8
Los Angeles, CA	403550	375506	93.1	15	26903	421	958.6
San Diego, CA	407720	388276	95.2	15	27181	416.2	979.6
Washington, DC	316499	249766	78.9	27	11722	609.3	519.4
All Sites	**2064060**	**1902196**	**92.2**	**163**	**12663**	**2625.3**	**786.2**

Table 2-2. Vehicle Utilization Information

Site	Possible Days Use	Actual Days Use	Pct. Days Used
Argonnne	1860	1350	72.6
Bakersfield	4973	4459	89.7
Washington, DC	12692	6736	53.1
Detroit	13260	7505	56.6
El Paso	4881	3767	77.2
Los Angeles	8770	5515	62.9
San Diego	8672	6470	74.6
All Vehicles	**55108**	**35802**	**65**
Veh. Type	**Possible Days Use**	**Actual Days Use**	**% Days Used**
CNG Dodge Van	5642	4990	88.4
CNG C-2500 Pickup	5390	4205	78
E85 Lumina	682	381	55.9
Gas Cntl. Lumina	3845	2455	63.8
Gas Cntl. Taurus	3428	2252	65.7
M85 Lumina	12195	7093	58.2
M85 Lumina Ctrl	2470	1238	50.1
M85 Taurus	19227	11834	61.5
M85 Taurus Ctrl	2229	1354	60.7
Vehicle Class	**Days Possible Use**	**Days Actual Use**	**% Days Used**
AFV Alcohol	31422	18927	60.2
Alcohol Control	4699	2592	55.2
Gas Control	7273	4707	64.7
CNG Vehicle	11032	9195	83.4

Table 2-3. Vehicle Utilization Information

Site	M85 Gals. Consumed	Gasoline Gals. Consumed	Percent M85 Use
Detroit, MI	13683	768.6	94.7
Los Angeles, CA	7696.6	2482	75.6
San Diego, CA	8027.3	2899.3	73.5
Washington, DC	10167.9	1441.9	87.6
Total	**39574.8**	**7591.8**	**83.9**

Table 2.4. Unscheduled Maintenance Evaluation

Site	DriverUnsched.	ShopUnsched.	Pct.(Driver/Shop)
Washington, DC	94	414	22.7
Detroit, MI	98	256	38.3
Los Angeles, CA	66	91	72.5
San Diego, CA	46	30	153.3
All Sites	**304**	**791**	**38.4**
Vehicle Type			
GLC	17	18	94.4
GTC	3	2	150
ML	72	95	75.8
MLC	13	12	108.3
MT	179	634	28.2
MTC	20	30	66.7
Vehicle Class			
AFV_ALC	251	729	34.4
CNTRL_ALC	33	42	78.6
CNTRL_GAS	20	20	100

3.0 Fuel Economy Analysis

Currently, there are approximately 11,000 driver-reported refueling occurrences in the AFDC representing more than 106,000 gallons of fuel used and nearly 2 million miles driven. Table 3-1 shows the numbers and types of vehicles participating in the AMFA demonstration program along with the number of refuel occurrences and types of fuel used.

Number of Refuel Records by Vehicle Type

Table 3-1

Vehicle Type	Vehicles Reporting	Fuel Type	Number of Refuels
Chevrolet Lumina M85 VFV	21	Gasoline	382
		M85	2087
Chevrolet Lumina M85 VFV (gasoline control)	4	Gasoline	269
		M85	4
Chevrolet Gasoline Lumina	8	Gasoline	564
Ford Taurus M85 FFV	36	Gasoline	479
		M85	2109
Ford Taurus M85 FFV (gasoline control)	3	Gasoline	212
Ford Gasoline Taurus	8	Gasoline	552
Chevrolet CNG Pickup	48	CNG	1235
Dodge CNG Van	20	CNG	2880
Chevrolet Lumina E85 VFV	5	E85	38
		Gasoline	47

Drivers of the AMFA demonstration vehicles were instructed to record the odometer, fuel type, and fuel amount added each time they refuel their vehicles. From this, a fuel economy calculation can be performed at each refuel. Drivers also report the beginning and ending odometer each day the car is driven. This information provides an indication of how the vehicle is being utilized. Very high daily mileages suggest that the vehicle is being used under highway conditions for at least a portion of the daily usage, while very low daily mileages suggest that the vehicle is being used for shorter trips. This information is not absolute because a mid-range daily mileage may be due to many short trips, a single medium-length highway trip, or a mixture of both. Data on the length of every individual trip driven are not collected because this would be far too time consuming for the vehicle operators.

The AMFA demonstration fleet is operated under "real world" applications meeting the federal GSA fleet transportation needs throughout the United States (see Section 1 for further information on the size and distribution of the fleet). The "real world" nature and distribution of the fleet contribute to several sources of error in the data reported. Fuel economy calculated after each refuel will only be correct if every refuel is recorded, and the information associated with each refuel is recorded accurately. Also, the fuel tank must completely be filled, although this source of error is eliminated if fuel economy is calculated over a series of refuels ending in a fillup (as long as all previously mentioned information is recorded accurately and completely). When determining the fuel economy of flexible or variable fuel vehicles (FFVs or VFVs), it must taken into account that the vehicle may be operated on either gasoline or the alternative fuel (M85 or E85). Therefore, the mixture of methanol (or ethanol) and gasoline in the fuel tank between refuels can only be known if all information at every refuel is recorded completely and accurately. The determination of fuel economy is further complicated by factors such as the variability in composition and energy content of the alternative fuels being demonstrated (M85, E85, and CNG), environmental conditions, and maintenance status of each vehicle.

The paragraphs that follow will display the level of variability that currently exists in the data base, show that it is <u>not</u> sufficient to merely divide the total miles driven by the total gallons of fuel that were reportedly used, and will provide a statistical methodology for determining fuel economy within a reasonable level of certainty. The fuel economy results will also be divided into categories of high (>100 miles per day), medium (>50 and <100 miles per/day), and low (<100 miles per day) daily mileage and compared to chassis dynamometer determinations of fuel economy using the Federal Test Procedure (FTP) city driving cycle and the Highway Fuel Economy Test (HWFET). It will be shown how this type of categorization can explain some of the variability in the data base.

Figure 3-1 shows several curves that represent the distribution of fuel economy values calculated after each refuel. These curves were generated from the "raw" data existing in the AFDC. Although a substantial effort is made to ensure the quality of the data before they are entered into the data base, no additional statistical methodology was applied to the data shown in figure 3-1. The CNG data shown are derived from 4,047 refuels of both Dodge CNG vans in Bakersfield and Chevrolet CNG pickups in El Paso. The FFV data shown are derived from 5,000 refuels of 1991 Ford Taurus M85 FFVs and 1991 Chevrolet Lumina M85 VFVs operating on both M85 and gasoline. The FFV control data shown are derived from 479 refuels of 1991 Ford Taurus M85 FFVs and 1991 Chevrolet Lumina M85 VFVs operating on gasoline alone. The gasoline control data shown are from 1991 Ford Taurus M85 FFVs and the 1991 Chevrolet Lumina M85 VFVs operating on gasoline. A quick glance at the figure reveals that the data collected from the CNG vehicles are extremely tight in comparison to the other three data sets. One obvious reason for the difference in variability between the CNG data and the FFV data is that the CNG vehicles are "dedicated," operating on a single fuel, while the FFV vehicles can and do operate on a varying blend of M85 and gasoline. However, the FFV control and gasoline control vehicles use only gasoline, and the data show an even higher degree of variability. Apparently there are other factors to consider, such as education of the drivers, feedback, and encouragement of participation in the data collection program.

3.1 CNG Refueling Data

Approximately 70% of the CNG data (2,860 refuels) are from the demonstration of Dodge CNG vans operating at the Naval Petroleum Reserve (NPR) in Bakersfield, CA (see Figure 3-2). These vehicles are being utilized in a van pool transporting employees to and from work. The vehicles refuel at a single location, and are driven by a relatively small group of employees under very similar driving conditions each day. Also, the fleet coordinator at NPR remains in close contact with the drivers and closely oversees the status of the vehicles. Figure 3-2 clearly indicates that the CNG demonstration fleet at NPR has provided the highest quality refueling data in the entire program.

Further study of the data from NPR yields a methodology for identifying and removing outliers. Because the distribution of data is normal and appears symmetrical, data were removed based on the standard deviation (SD) of the entire data set. First, data outside the bounds of the average of all calculated individual fuel economies (IFE) plus or minus two times the SD were removed. This required the removal of 87 records or approximately 3% of the data. Similarly, data outside the bounds of IFE +/- 1.0 SD and IFE +/- 0.5 SD resulted the removal of 201 (7%) and 294 (10%) records, respectively. The IFE and the total miles reported divided by the total miles driven (TFE) are plotted versus the percentage of the refueling records remaining after removing outliers as described above (see Figure 3-3 and Table 3-2). The figure shows that the change in fuel economy (IFE or TFE) decreases dramatically if more than 7% of the data is removed. This analysis also shows that the difference between the average of indivual readings (IFE) and the overall miles per gallon (IFE) is substantially decreased after removing 7% of the data as outliers.

3.1.1 CNG Fuel Economy Results

The resulting total calculated fuel economy (TFE) for the CNG vehicles at the NPR is 10.1 miles per equivalent gallon of gasoline. This value is shown in Figure 3-2. The CNG Vans at Bakersfield are frequently driven with up to nine passengers, which may account for a lower fuel economy. (The EPS adjusted fuel economy estimates for a standard gasoline van of this make and model are 12 mpg city and 14 mpg highway). A similar analysis performed on the data from the CNG Chevrolet pickups in El Paso is shown in Table 3-3 and Figure 3-4. The resulting overall calculated fuel economy for the CNG vehicles at El Paso is 13.6 miles per equivalent gallon of gasoline. This value is also shown in Figure 3-2. The EPS adjusted fuel economy estimates for a standard gasoline pickup of the same make and model are 14 mpg city and 19 mpg highway. The vehicle usage patterns at the El Paso site and the Bakersfield site are compared in Figure 3-5. The CNG pickups at El Paso are driven over a fairly wide range of shorter trips between 0 and 50 miles per day, while the CNG Vans at Bakersfield are more driven more regularly within two distinct usage patterns (one at an average of 48 miles per day, and another at an average of 85 miles per day). This may account for the wider distribution of fuel economy for the El Paso CNG pickups. Data from gasoline control vehicles are just starting to be collected at both sites and should provide insight into the comparison between the CNG-and gasoline-powered vehicles. A final indicator of the accuracy of the CNG pickup fuel economy data from El Paso is a set of chassis dynamometer data that the AFDC recently received. The chassis dynamometer results show a fuel economy of 11.8 miles per equivalent gallon on the city cycle and 17.8 on the highway cycle.

3.2 M85 Refueling Data

As was discussed earlier, the individual fuel economy data from the M85 flex- or variable fueled vehicles are considerably more scattered than those from the dedicated CNG vehicles. Figure 3-6 shows a series of frequency distribution curves for the individual fuel economy calculations from all the data collected from Chevrolet M85 VFV Luminas. This series of curves also depicts the approach that was used to determine the actual in-use fuel economy for VFVs operating on M85.

The first step in this process is to segregate refueling data of operating vehicles on M85 from vehicles operating on an unknown mixture of M85 and gasoline. To do this, data from gasoline refuels and the following four consecutive M85 refuels were not used in this analysis. Figure 3-6 shows the amount of data that has been eliminated from this analysis to ensure that the fuel economy being calculated is for M85 only. Upon removing these data, it becomes fairly obvious that there is still a significant amount of variability. In fact, a closer look at Figure 3-6 indicates that there could possibly be three separate regimes of fuel economy values.

The second step taken in attempting to narrow the range of fuel economy values was to study the effect of vehicle usage. An average daily mileage was calculated for each refuel of every vehicle. This represents the average daily miles driven between refuels. Next, the individual fuel economy data were segregated into three daily usage regimes. For the case of the VFV Luminas, these regimes are:

I. Average Daily Mileage less than 50 (466 refuel records)
II. Average Daily Mileage greater than 50, but less than 100 (539 refuel records)
III. Average Daily Mileage greater than 100 (231 refuel records).

The frequency distributions for the three regimes are shown in Figure 3-6 and in more detail in Figure 3-7.

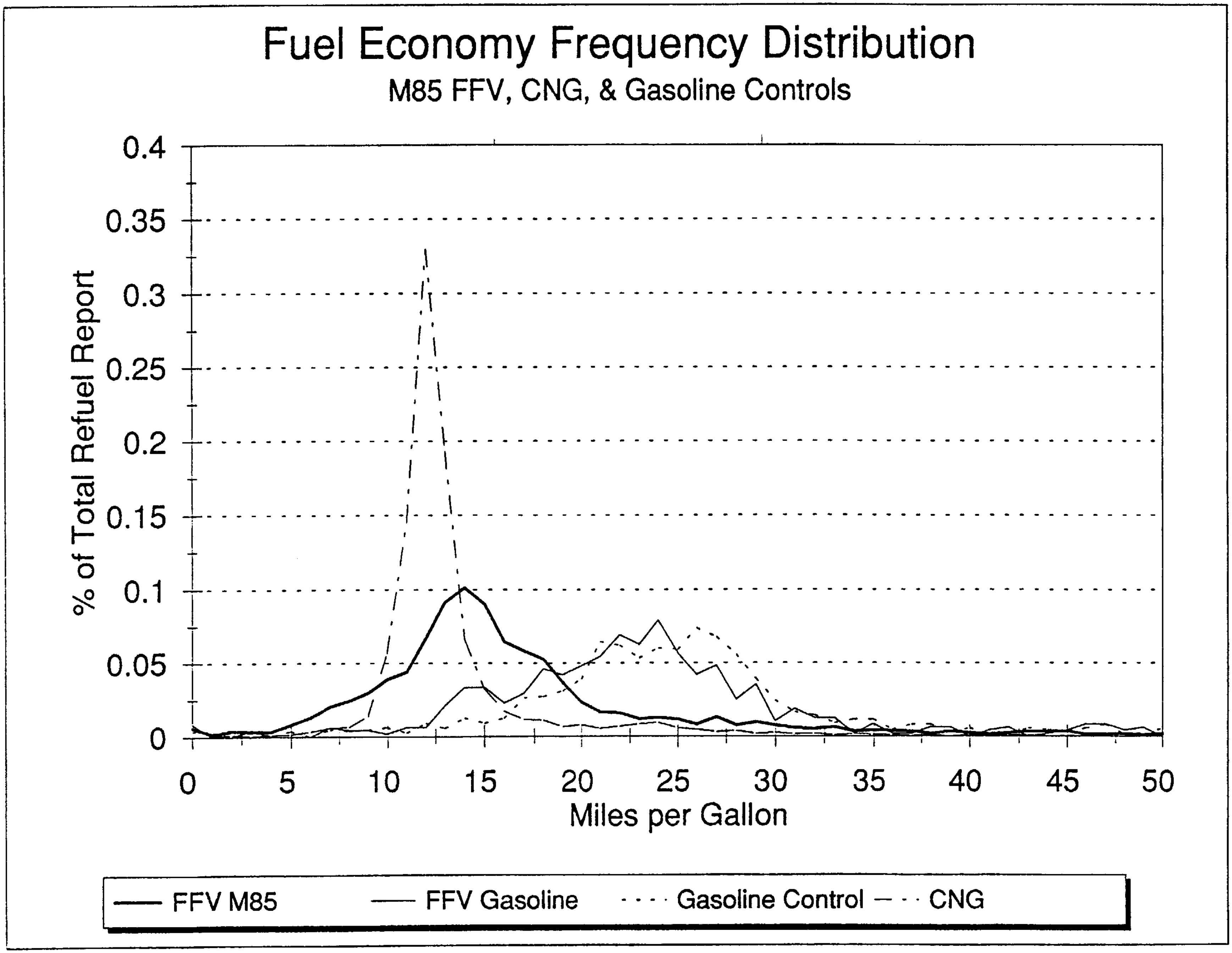
The final step in the process is to eliminate outlier data from each of the three daily usage regimes by studying the three separate frequency distributions as was described in the analysis of CNG refueling, and then calculate an overall fuel economy for each regime by dividing the total miles driven by the total gallons of fuel added. These steps were carried out separately for the Chevrolet VFV M85 Luminas, the Chevrolet VFV Luminas operated on gasoline, the standard Chevrolet Luminas, the Ford FFV M85 Tauruses, the Ford FFV Tauruses operated on gasoline, and the standard Ford Tauruses. The results of this analysis are shown in Table 3-4 and Figure 3-8a for the Chevrolet vehicles, and Table 3-5 and Figure 3-8b for the Ford vehicles. The results of chassis dynamometer fuel economy measurements for both FTP city driving cycle and HWFET are also presented in these tables and figures for comparison to the driver-reported (in-use) data.

A similar analysis was performed for the following vehicle types: Lumina stock, Lumina VFV control, Taurus stock, and FFV Taurus. Details of this analysis are shown in Figures A3-1 to A3-11 in Appendix 3.

Section 3.2.1 M85 Fuel Economy Results

In the case of the Chevrolet Luminas, M85 vehicles, the increase in fuel economy from regime I to regime II is appoximately 24% while the increase from regime II to regime III is approximately 12%. For the Ford Taurus M85 vehicles, the increase in fuel economy from regime I to regime II is approximately 18%) while the increase from regime II to regime III is approximately 10%. In both cases the fuel economy values from all three regimes fall between the city and highway fuel economies measured on the chassis dynamometer (11mpg city, 20 mpg highway). Using a value of 115000 BTU/Gal of gasoline and 67800 BTU/Gal, there is a very little difference in the fuel economy of M85 powered vehicles versus gasoline powered vehicles when compared on an energy basis (see M85 equivalent Figures 6-8a ad 6-8b.

Figure 3.1



Fuel Economy Frequency Distribution
M85 FFV, CNG, & Gasoline Controls
% of Total Refuel Report
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
5
10
15
20
25
30
35
40
45
50
Miles per Gallon
FFV M85
FFV Gasoline
Gasoline Control
CNG

Figure 3.2

CNG Fuel Economy

Frequency Distribution by Site

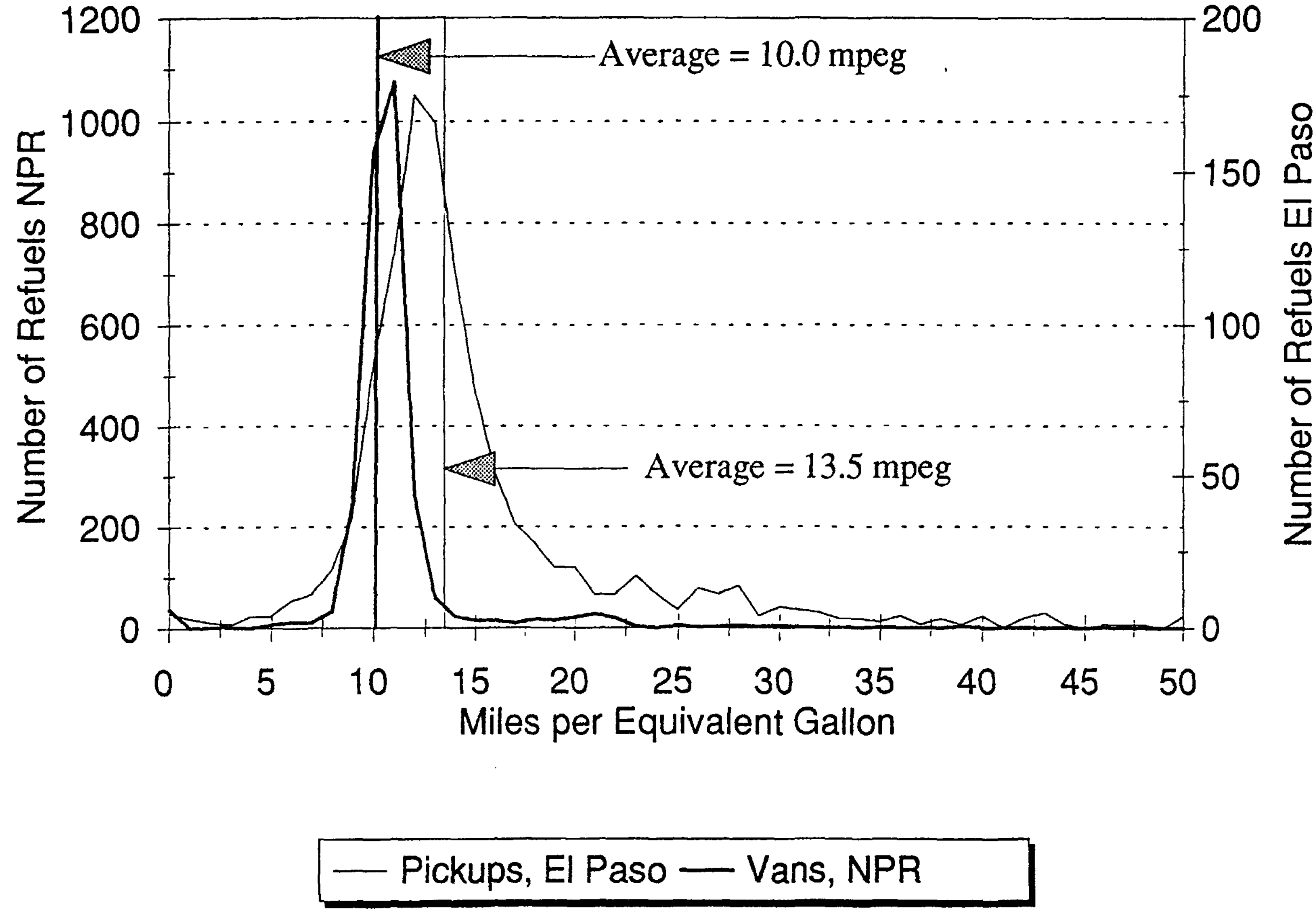


Table 3.2

Bakersfield (NPR), Dodge CNG Vans

	All Refueling Data	Average +/- 2 SD	Average +/- 1 SD	Average +/- 0.5 SD
Total Number of Refuels (N) :	2880	2793	2679	2586
% of Total Records	100.00	96.98	93.02	89.79
Avg. of Individual Readings (Avg) :	10.71	10.43	10.13	10.12
Standard Deviation (SD) :	5.63	2.13	1.13	0.87
Maximum Fuel Economy (FEmax)	178.92	21.63	16.43	13.57
Minimum Fuel Economy (FEmin)	-11.97	0.99	5.34	8.00
Total Miles / Total Equiv Gallons	10.55	10.36	10.08	10.08

Figure 3.3

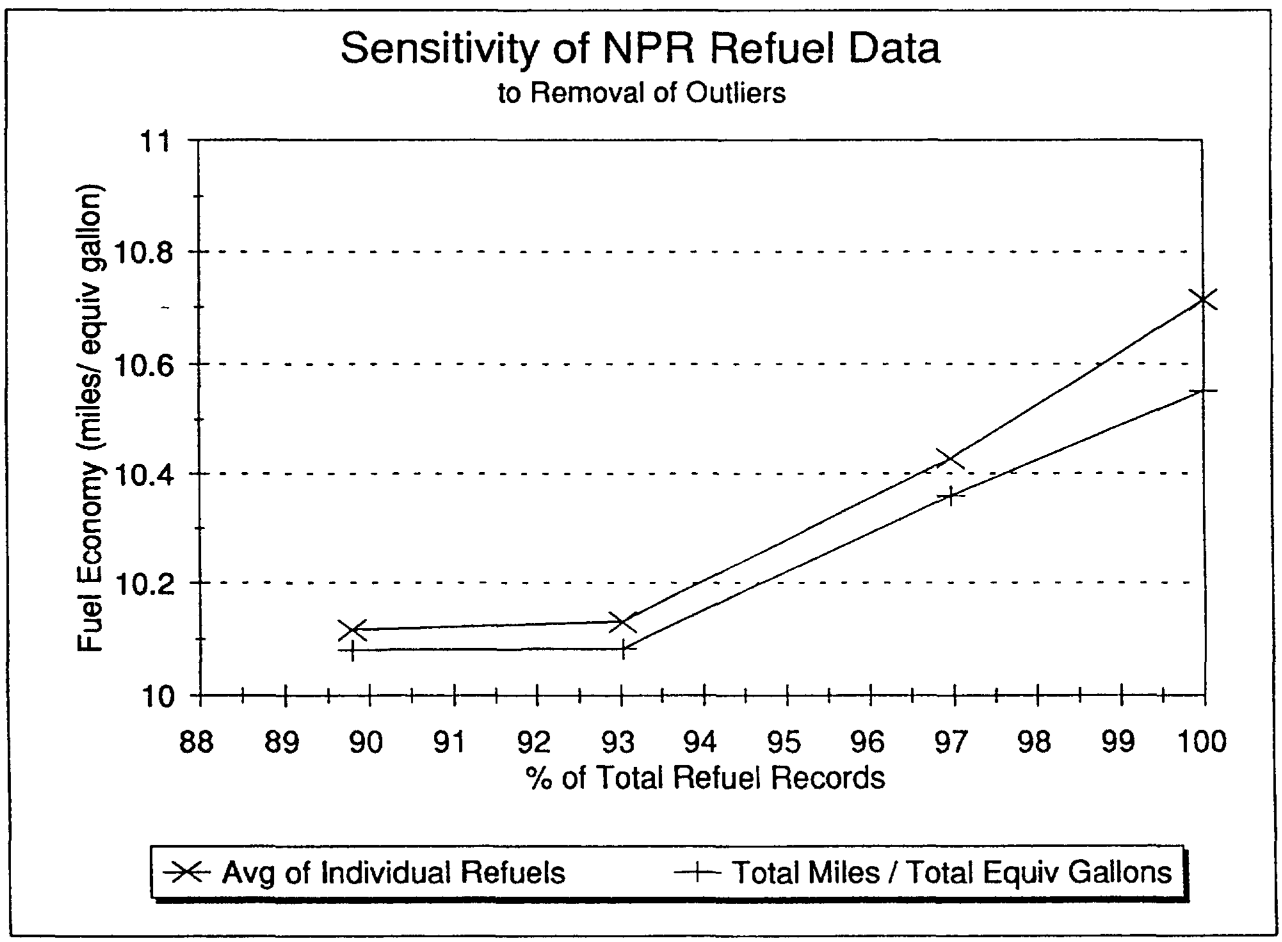


Table 3.3

EL Paso, Chevrolet CNG Pickups

	All Refueling Data	Average +/- 2 SD	Average +/- 1 SD	Average +/- 0.5 SD
Number of Refuels (N)	1187	1156	1122	1031
Percent of Total Records	100	97.39	94.52	86.86
Avg. of Individual Refuels (IFE)	17.23	14.61	13.88	13.5
Standard Deviation (SD)	19.66	7.43	5.4	3.85
Maximum Fuel Economy (FEmax)	279.54	55.4	36.56	27.05
Minimum Fuel Economy (FEmin)	-14.77	-14.77	0	7.56
Total Miles / Total Equiv Gallons (TFE	15.36	14.2	13.62	13.27

Figure 3.4

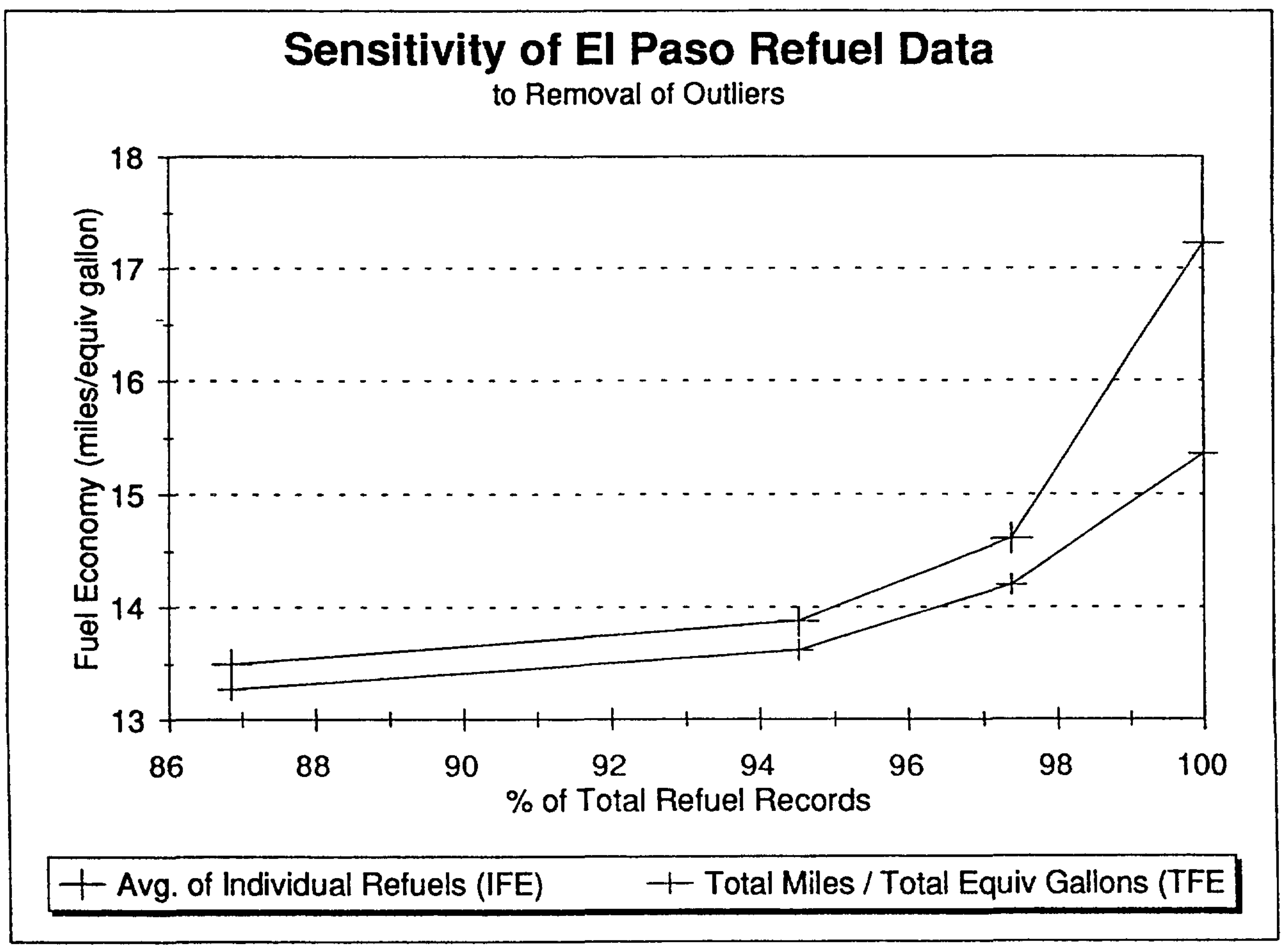


Figure 3-5

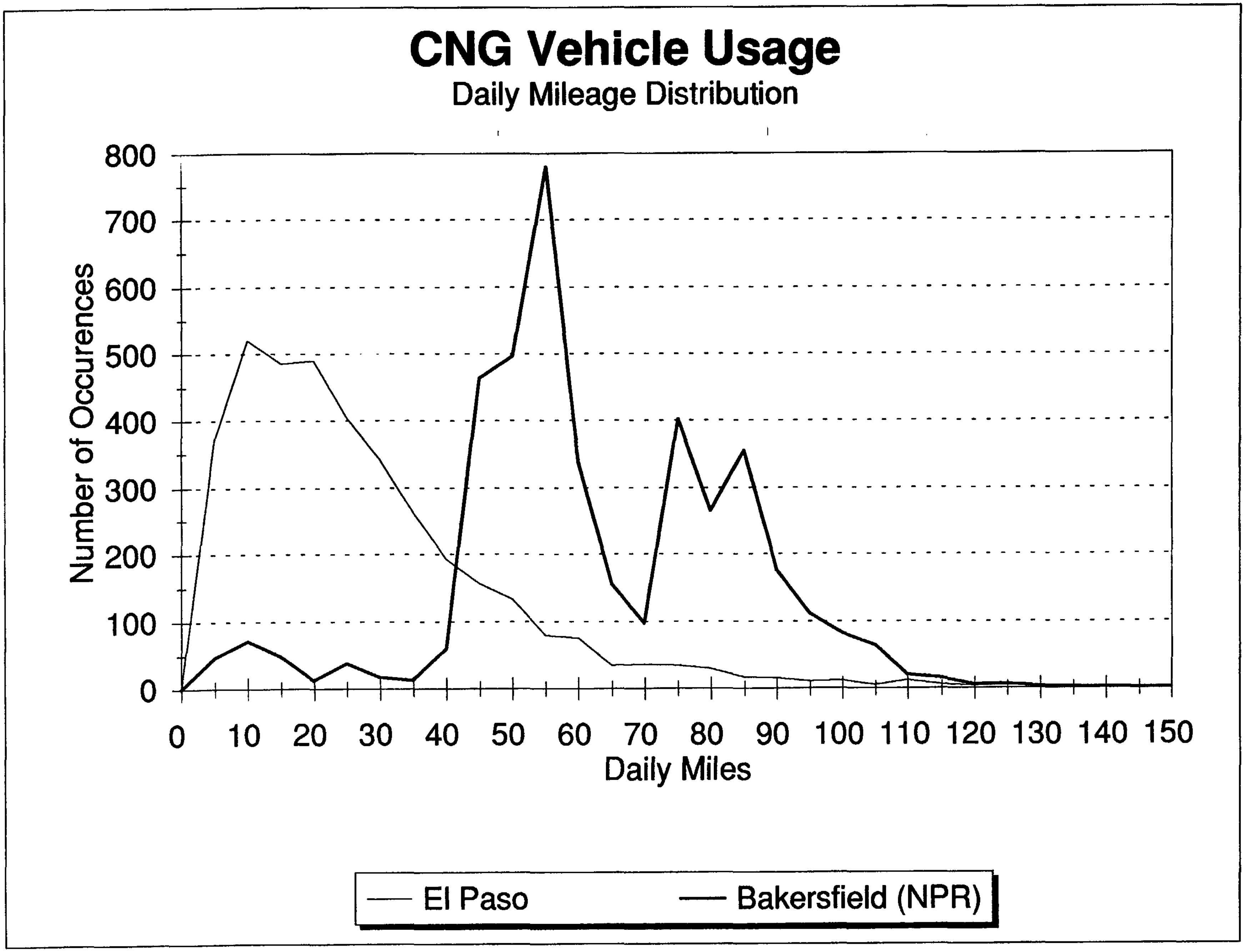
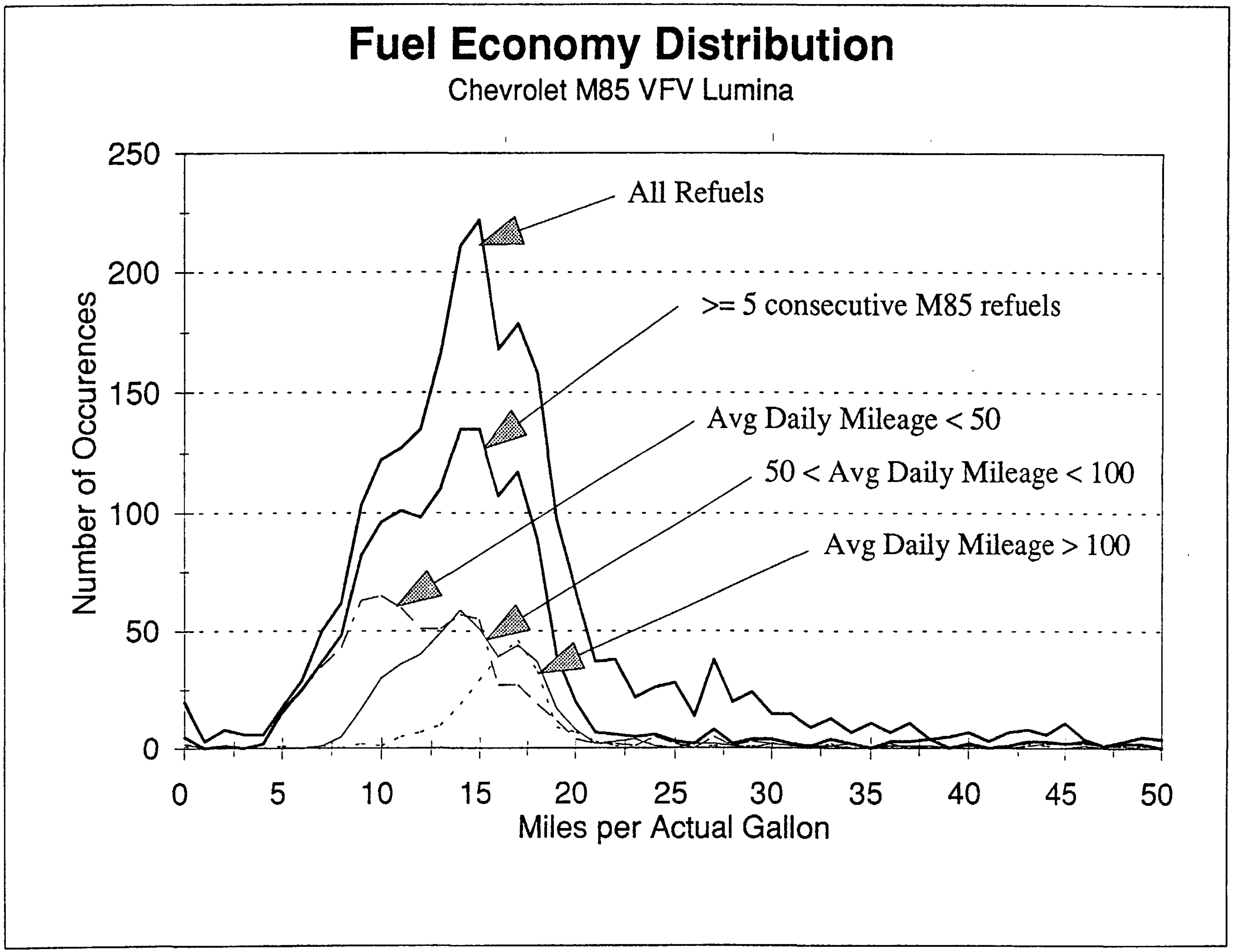
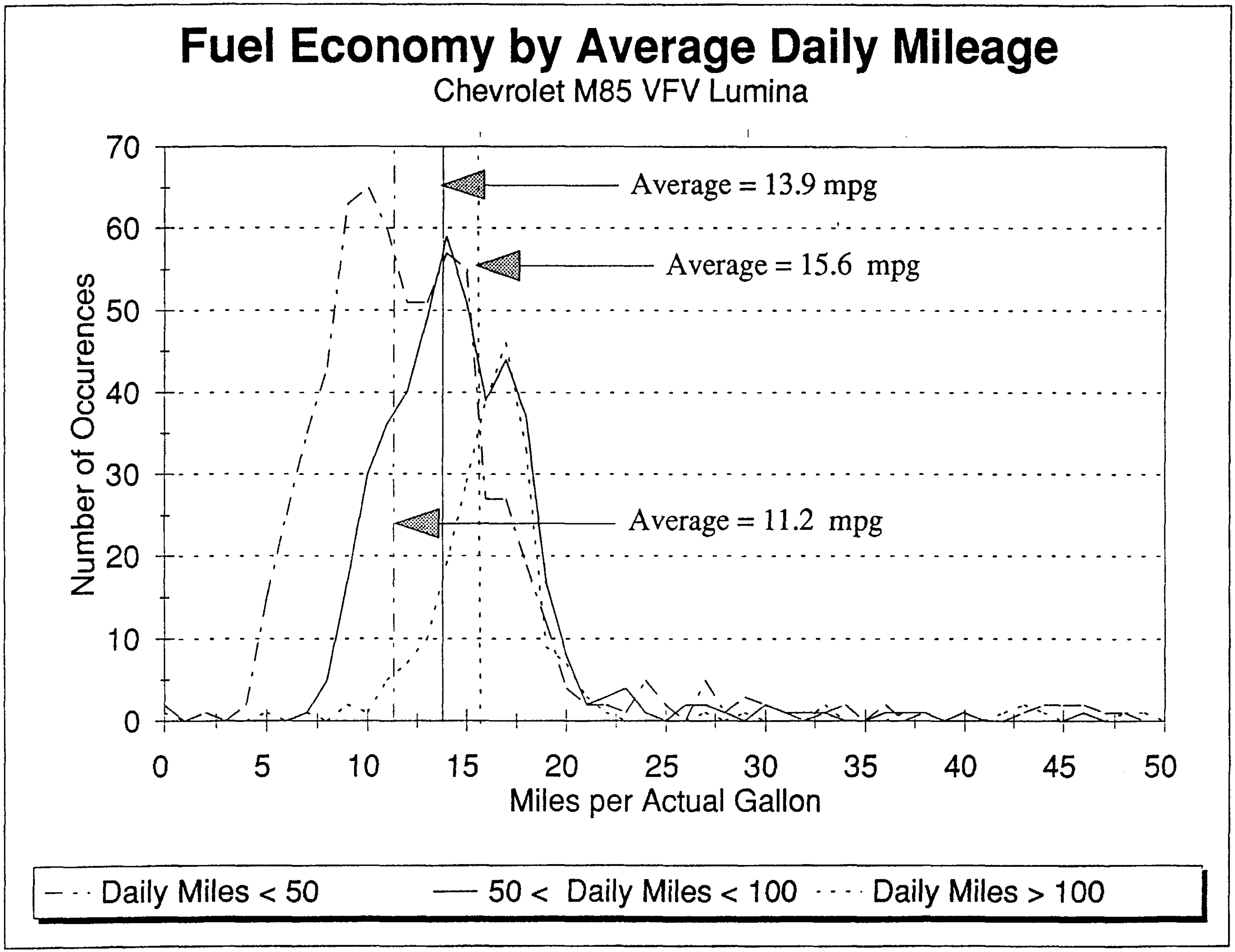

CNG Vehicle Usage
Daily Mileage Distribution
800
700
600
500
400
300
200
100
0
Number of Occurences
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
Daily Miles
El Paso
Bakersfield (NPR)

Figure 3.6



Fuel Economy Distribution
Chevrolet M85 VFV Lumina
All Refuels
>= 5 consecutive M85 refuels
Avg Daily Mileage < 50
50 < Avg Daily Mileage < 100
Avg Daily Mileage > 100
Number of Occurences
250
200
150
100
50
0
0
5
10
15
20
25
30
35
40
45
50
Miles per Actual Gallon

Figure 3.7



Fuel Economy by Average Daily Mileage
Chevrolet M85 VFV Lumina
Number of Occurences
0
10
20
30
40
50
60
70
0
5
10
15
20
25
30
35
40
45
50
Miles per Actual Gallon
Average = 13.9 mpg
Average = 15.6 mpg
Average = 11.2 mpg
Daily Miles < 50
50 < Daily Miles < 100
Daily Miles > 100

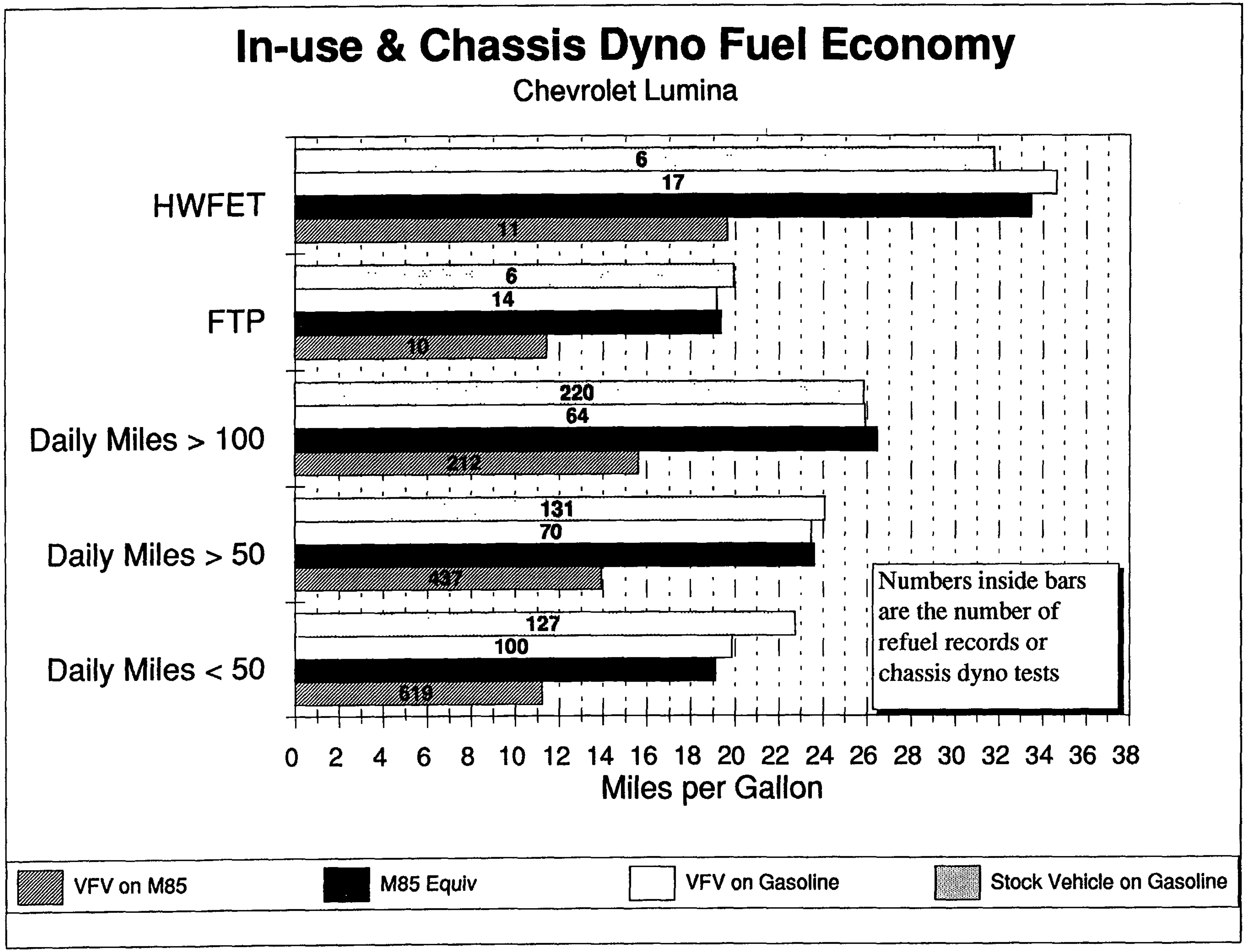
Table 3-4 Chevrolet Lumina Fuel Economy Results

Vehicle Type	Fuel Type	Vehicle Usage / Test Type	Total Miles Driven / Total Gallons Used	Number of Refuels / Tests
VFV Lumina	M85	Daily Miles < 50	11.24	619
VFV Lumina	M85	Daily Miles > 50	13.90	437
VFV Lumina	M85	Daily Miles > 100	15.60	212
VFV Lumina	M85	FTP	11.39	10
VFV Lumina	M85	HWFET	19.68	11
VFV Lumina	Gasoline	Daily Miles < 50	19.86	100
VFV Lumina	Gasoline	Daily Miles > 50	23.47	70
VFV Lumina	Gasoline	Daily Miles > 100	25.92	64
VFV Lumina	Indolene	FTP	19.16	14
VFV Lumina	Indolene	HWFET	34.62	17
Gasoline Lumina	Gasoline	Daily Miles < 50	22.73	127
Gasoline Lumina	Gasoline	Daily Miles > 50	24.09	131
Gasoline Lumina	Gasoline	Daily Miles > 100	25.86	220
Gasoline Lumina	Indolene	FTP	19.97	6
Gasoline Lumina	Indolene	HWFET	31.75	6

Table 3-5 Ford Taurus Fuel Economy Results

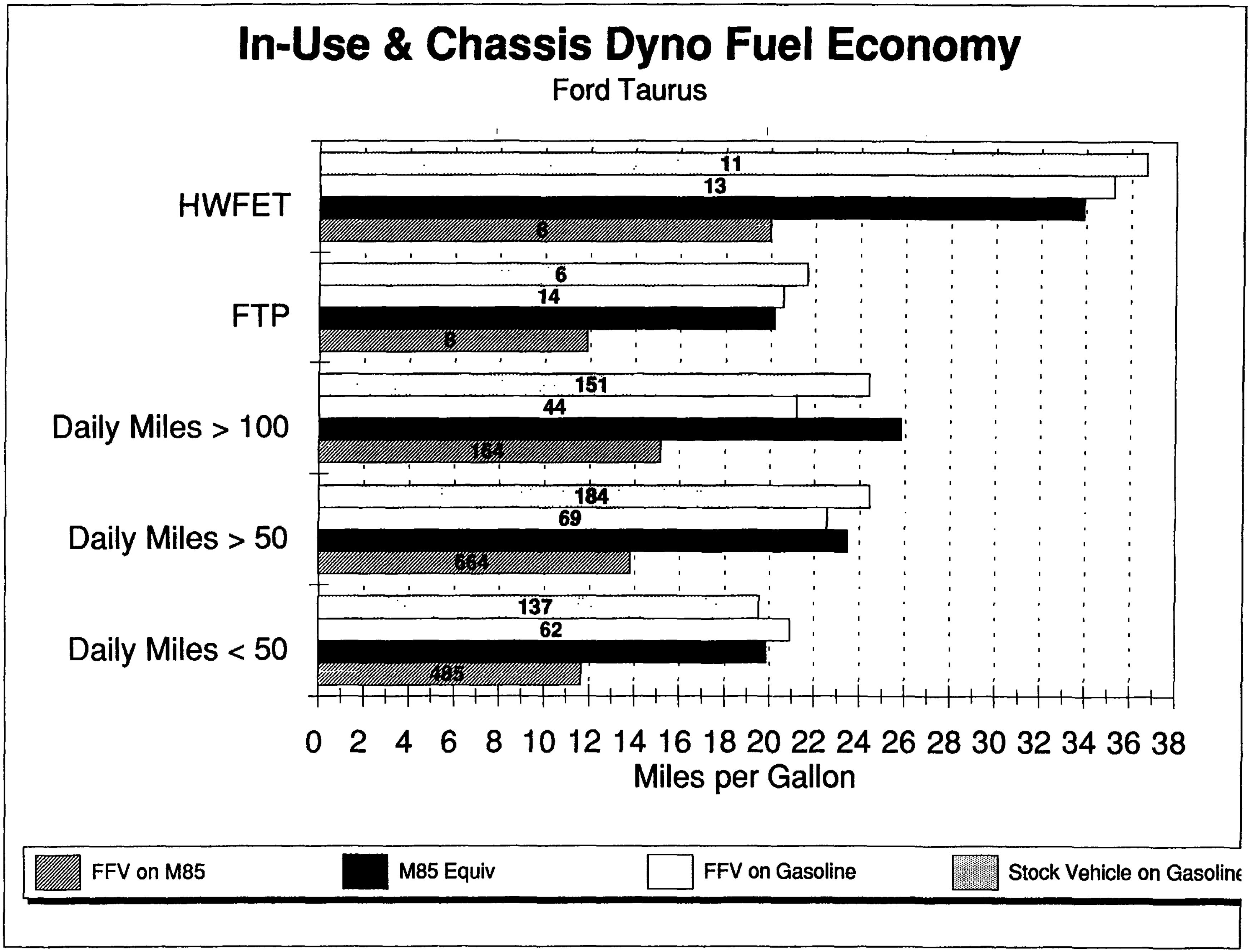
Vehicle Type	Fuel Type	Vehicle Usage / Test Type	Total Miles Driven / Total Gallons Used	Number of Refuels / Tests
FFV Taurus	M85	Daily Miles < 50	11.68	485
FFV Taurus	M85	Daily Miles > 50	13.81	664
FFV Taurus	M85	Daily Miles > 100	15.17	164
FFV Taurus	M85	FTP	11.88	8
FFV Taurus	M85	HWFET	19.95	8
FFV Taurus	Gasoline	Daily Miles < 50	20.96	62
FFV Taurus	Gasoline	Daily Miles > 50	22.55	69
FFV Taurus	Gasoline	Daily Miles > 100	21.16	44
FFV Taurus	Indolene	FTP	20.56	14
FFV Taurus	Indolene	HWFET	35.24	13
Gasoline Taurus	Gasoline	Daily Miles < 50	19.52	137
Gasoline Taurus	Gasoline	Daily Miles > 50	24.44	184
Gasoline Taurus	Gasoline	Daily Miles > 100	24.39	151
Gasoline Taurus	Indolene	FTP	21.63	6
Gasoline Taurus	Indolene	HWFET	36.71	11

Figure 3-8a



In-use & Chassis Dyno Fuel Economy
Chevrolet Lumina
HWFET
FTP
Daily Miles > 100
Daily Miles > 50
Daily Miles < 50
6
17
11
6
14
10
220
64
212
131
70
437
127
100
619
Numbers inside bars are the number of refuel records or chassis dyno tests
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38
Miles per Gallon
VFV on M85
M85 Equiv
VFV on Gasoline
Stock Vehicle on Gasoline

Figure 3-8b



In-Use & Chassis Dyno Fuel Economy
Ford Taurus
HWFET
FTP
Daily Miles > 100
Daily Miles > 50
Daily Miles < 50
11
13
6
6
14
8
151
44
164
184
69
664
137
62
485
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38
Miles per Gallon
FFV on M85
M85 Equiv
FFV on Gasoline
Stock Vehicle on Gasoline

Section 4.0 Performance and Unscheduled Maintenance

Performance is a subjective evaluation by the AMFA fleet drivers of the driveability of their vehicles. The drivers report annoying or troublesome incidences of stalling, power, idle quality, starting, and similar problems on each day they operate the vehicles. In general, maintenance represents repair and/or replacement actions that are unscheduled, and are reported by the maintenance facilities rather than the drivers. Data in each category are normally presented on an incidence per 1000 mile basis, using miles physically accumulated on the vehicles as of the end of each month. This mileage is higher than that used for vehicle operation calculations because performance and maintenance are related to physical use of the vehicle, not logged data. Charts showing which vehicles reported performance problems, and scheduled and unscheduled maintenance are provided in Appendix A.4.

4.1 Performance

Figure 4-1 shows the accumulated performance record of the methanol flexible fuel vehicles (FFVs) vehicles reporting in the AMFA I fleet and the accumulated mileage on these vehicles. The poor performance in the first month is an artifact of low mileage accumulation. After the first month of reporting, FFV vehicles running on M85 (65 vehicles) and control FFVs running on gasoline (8 vehicles) had similar frequencies of problems reported. After a year of reporting, the problems diminished to less than one per 10,000 miles. Figure 4-2 provides a magnified comparison of the control FFVs and the stock gasoline controls (16 vehicles). In the first year of operation, problems were reported by the drivers that related to the vehicle fuel system modifications. The record since then has been comparable for all three vehicle types, with the M85 vehicles showing a slightly greater (but not statistically defensible) number of problems than the two control categories. This suggests that once the initial problems inherent in new vehicles are solved, M85 FFVs will achieve similar performance to stock vehicles. To date the M85 vehicles have accumulated 1.14 million total miles of operation.

CNG vehicles (77 vehicles) located at Argonne, Bakersfield, and El Paso have a similar performance record. El Paso control vehicles (5) have not yet begun reporting. Driver-reported problems peaked about six months into the program and have been decreasing since, as shown in Figure 4-3. The number of problems appears to have peaked at twice that seen in the methanol program, again receding to acceptable levels after the initial period. Much of the additional number of problems are due to high reporting from El Paso, to be discussed in a later section. CNG vehicles had accumulated more than 424 thousand total miles of operation to date.

The specific kinds of problems reported by drivers are shown in Figures 4-4 and 4-5, for the M85 and CNG fleets, respectively. Idle quality and hesitation are the most common complaints for both fleets. Alternative fuel vehicles (AFVs) had significantly higher instances than stock vehicles. Note that these figures include the large number of problems seen in the early days of each program. Further, many of the reports come from only a few vehicles at each site (see Appendix A.4 for performance reporting records). Very few problems are currently being reported.

4.2 Performance Problems at El Paso

The first batches of performance data from El Paso were received at the AFDC in May 1993. These batches increased the overall number of complaints by 33%, even though El Paso represented only 5% of the total mileage in the data base. Figure 4-6 shows the exceptional peak seen in the total number of driver complaints. To understand this peak, the original reporting forms were reviewed. This review indicated that many drivers were entering multiple performance problems on a single day.

Figure 4-7 shows the number of instances of multiple reporting. Although most drivers reported only one or two problems in a day, significant numbers of drivers reported three or more. Figure 4-8 shows how multiple reporting contributed to the total number of complaints. Total number of complaints is thus not a useful measure of vehicle performance, but can be used to identify when a problem occurs in the fleet. A better indicator of fleet performance is to examine the number of vehicle operations in which a problem was reported divided by the number of vehicle operations (Figure 4-9). Thus, El Paso actually experienced a problem rate that is twice that of other sites. Idle quality and hesitation problems dominated the types of problems reported, decreasing with time (Figure 4-10). After installation of a third-generation fuel injector, the problem reporting has decreased to a level comparable with other sites.

4.3 Maintenance

Unscheduled maintenance reporting is shown in Figure 4-11 for the M85 FFV and M85 FFV control vehicles, and in Figure 4-12 for all control (gas and M85) vehicles. Maintenance data are not yet available for CNG vehicles. Once mileage reporting stabilized, initial instances of maintenance for M85 FFV vehicles represented about one instance per 5000 miles with vehicles operating on methanol, slightly higher than those operated on gasoline. The ratio of problems in M85 FFV controls to stock controls (in those months where good data have been received on the stock vehicles) suggests that a FFV vehicle will need maintenance about twice as often as a stock vehicle after the initial break-in period. This conclusion is, however, based on data that are insufficient for good statistical treatment. Stock control vehicles should have a steady repair occurrence rate approximating the industry standard for vehicles of that type. Given the monthly mileage accumulation on these vehicles, all unscheduled maintenance instances were not reported. Maintenance data on FFV control vehicles are likewise incomplete.

Although long-term maintenance data are insufficient at this time to predict the types of repairs that will be needed by M85 vehicles, an analysis of the early data can show where difficulties are encountered in developing M85 vehicles (Figure 4-13). Emission controls, wiring, pumps, fuel injection systems, and sensors were the most frequently required repair or replacement items. During the same period, no stock vehicles reported maintenance on emissions, fuel injection systems, or fuel pumps, an unlikely occurrence. The lack of data for stock control vehicles indicates that an estimate of the increased probability of failure for M85 components cannot be made at this time.

In addition to the sites that have not yet begun maintenance reporting (Argonne, Bakersfield, El Paso), 5 vehicles have never reported scheduled maintenance and 14 have never reported unscheduled maintenance, again indicating missing data. The remaining vehicles have reported a total of 791 maintenance requirements to date.

4.4 Relationship Between Performance Problems and Maintenance

The relationship between problems reported by drivers and unscheduled maintenance can be seen on the performance charts in Appendix A.4. At the Washington, DC site, 16 vehicles out of 27 reported performance problems for several weeks in a row. In 13 cases, these strings ended with an unscheduled maintenance and the problems did not repeat. At Detroit, 18 vehicles reported problem strings, with 16 reporting maintenance. In several of these cases, problems apparently returned and were often addressed again. At Los Angeles, 9 vehicles had repeating problems, with 7 being addressed by maintenance. At San Diego, 9 vehicles reported problems of this nature, with only 2 being addressed. At this site the problems appear to be sporadic, and often disappear without obvious corrective action. In nearly all cases, the problem strings occurred several years ago, indicating that current notification of OEMs and the site coordinators is not needed. If performance data can be made available rapidly enough, it would be possible to alert the site coordinators of developing problems, but this is not possible at present.

Scheduled maintenance is reported reliably for about half of the AMFA I fleet. Other vehicles generally report sporadically. Oil changes are the most common maintenance activity in the data base, but are still not always reported. This problem is improving -- data received in the last month have filled in a number of previous gaps in coverage. The low incidence of scheduled maintenance reporting suggests that unscheduled maintenance is likewise missing in many cases.

Figure 4-1. AMFA I (Methanol-Vehicle) Driver-Reported Performance

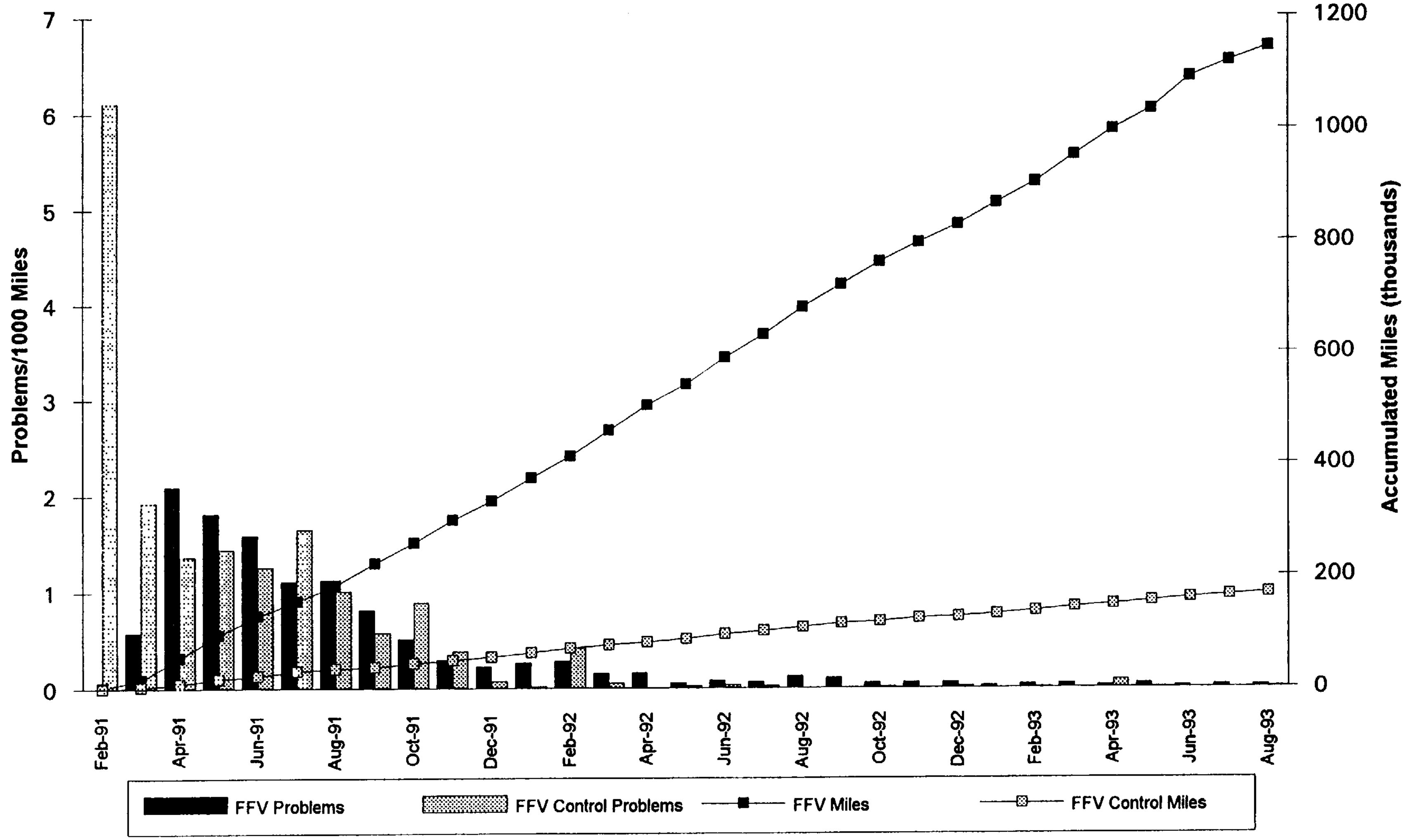


Figure 4-2. AMFA I (Control-Vehicle) Driver-Reported Performance

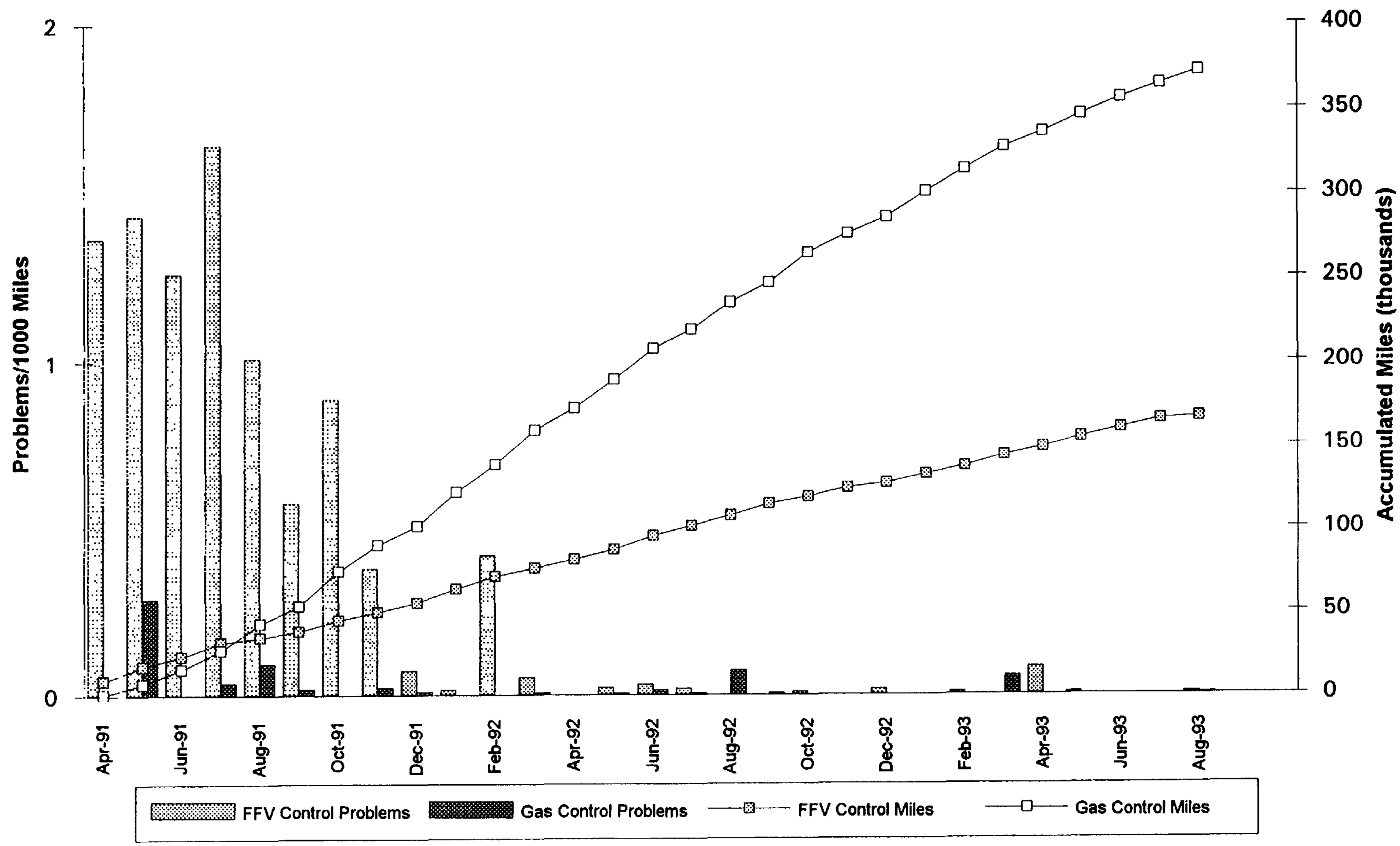


Figure 4-3. AMFA II (CNG-Vehicle) Driver-Reported Performance

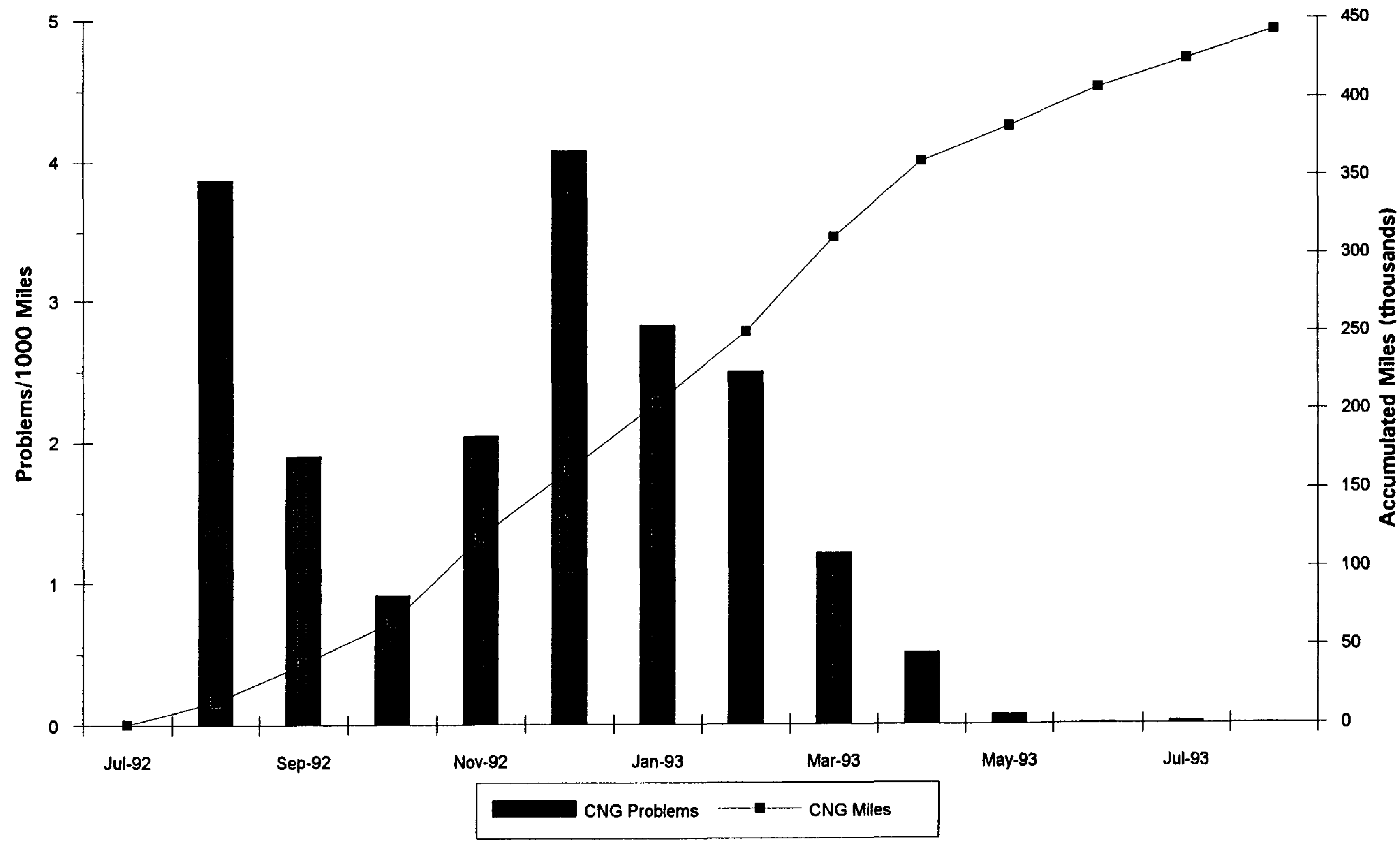


Figure 4-4. Driver - Reported Problems AMFA I Methanol Vehicles

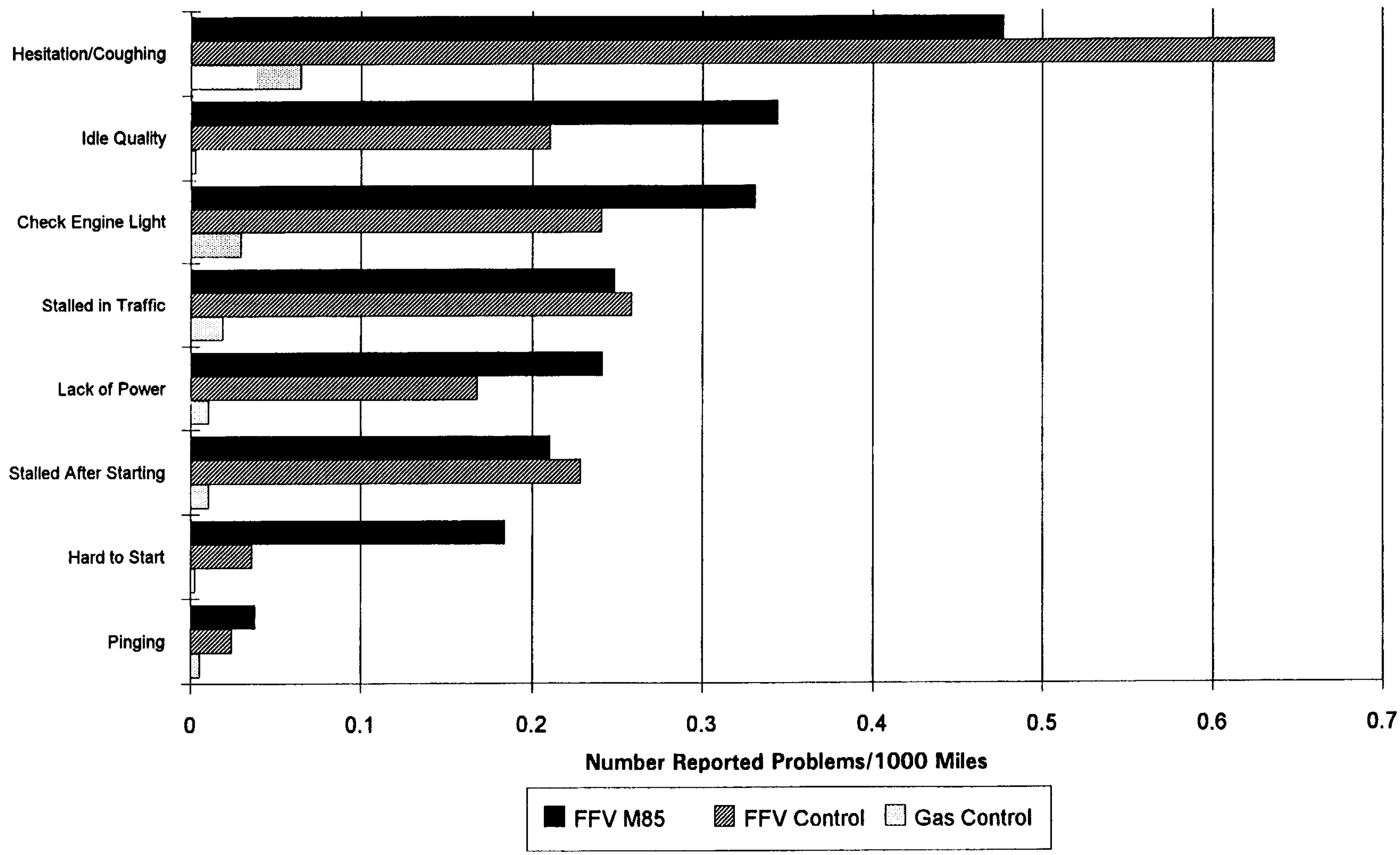


Figure 4-5. Driver - Reported Problems AMFA II CNG Vehicles

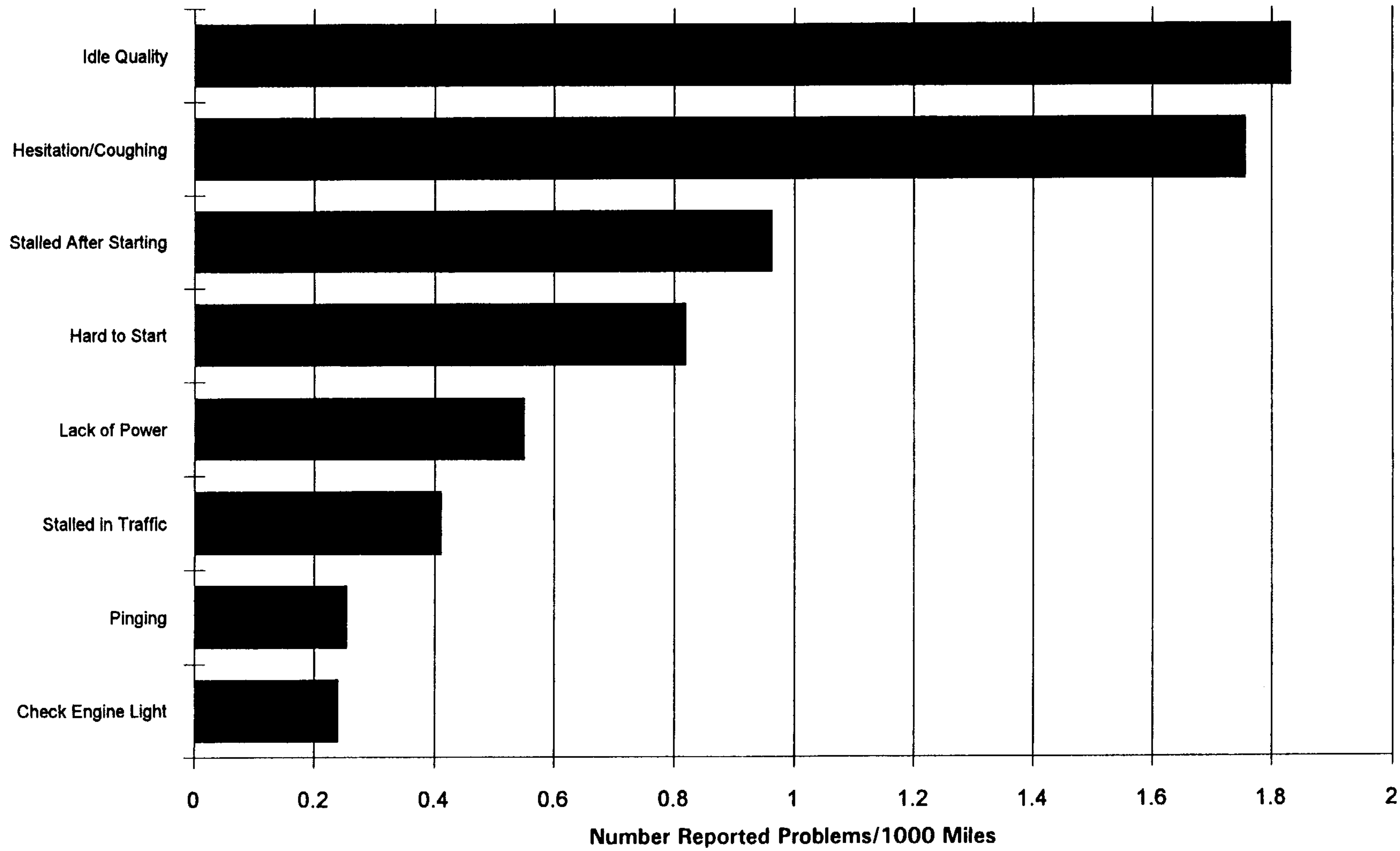


Figure 4-6. Driver-Reported Performance Problems

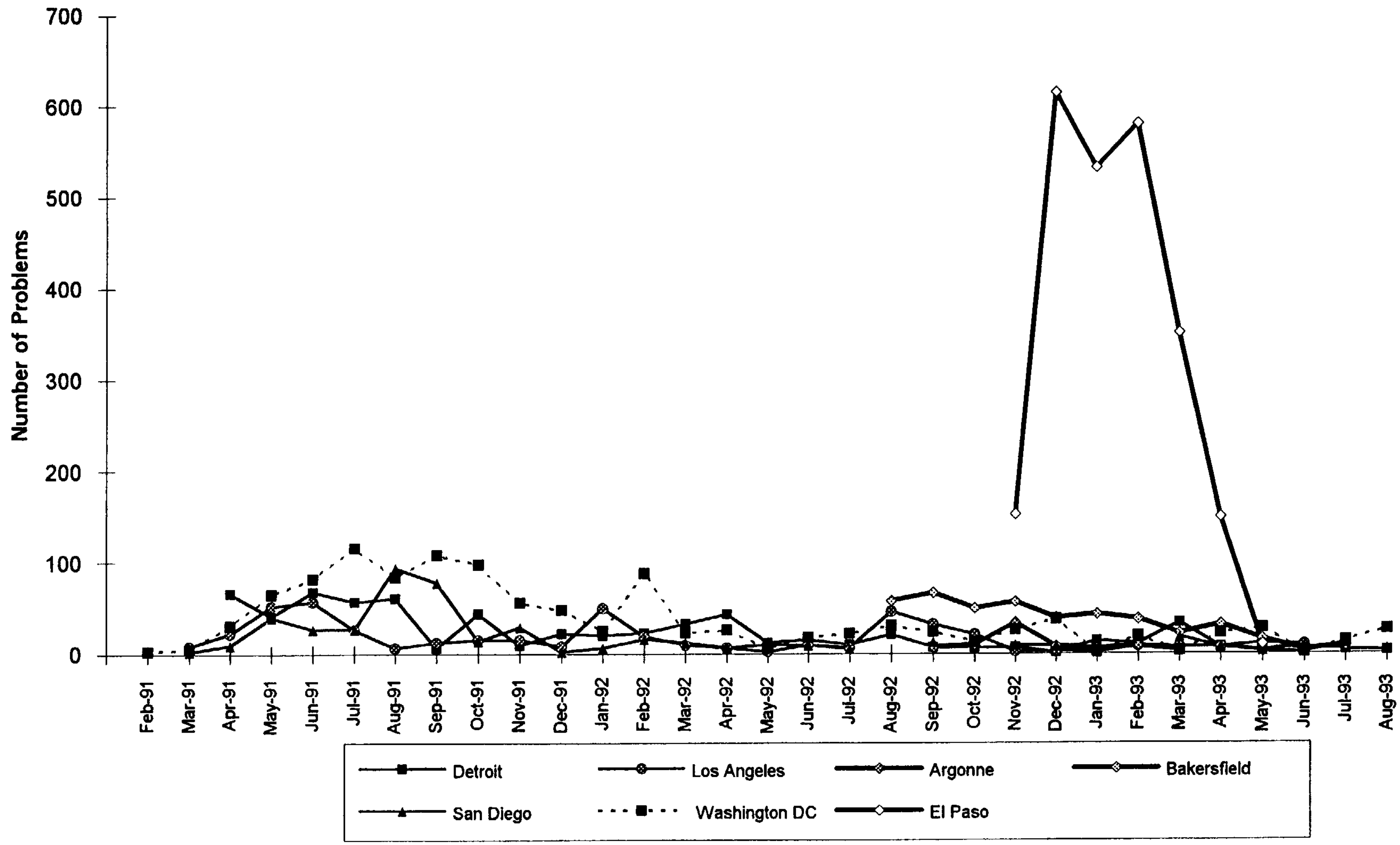


Figure 4-7. El Paso Reporting of Multiple Problems/Day

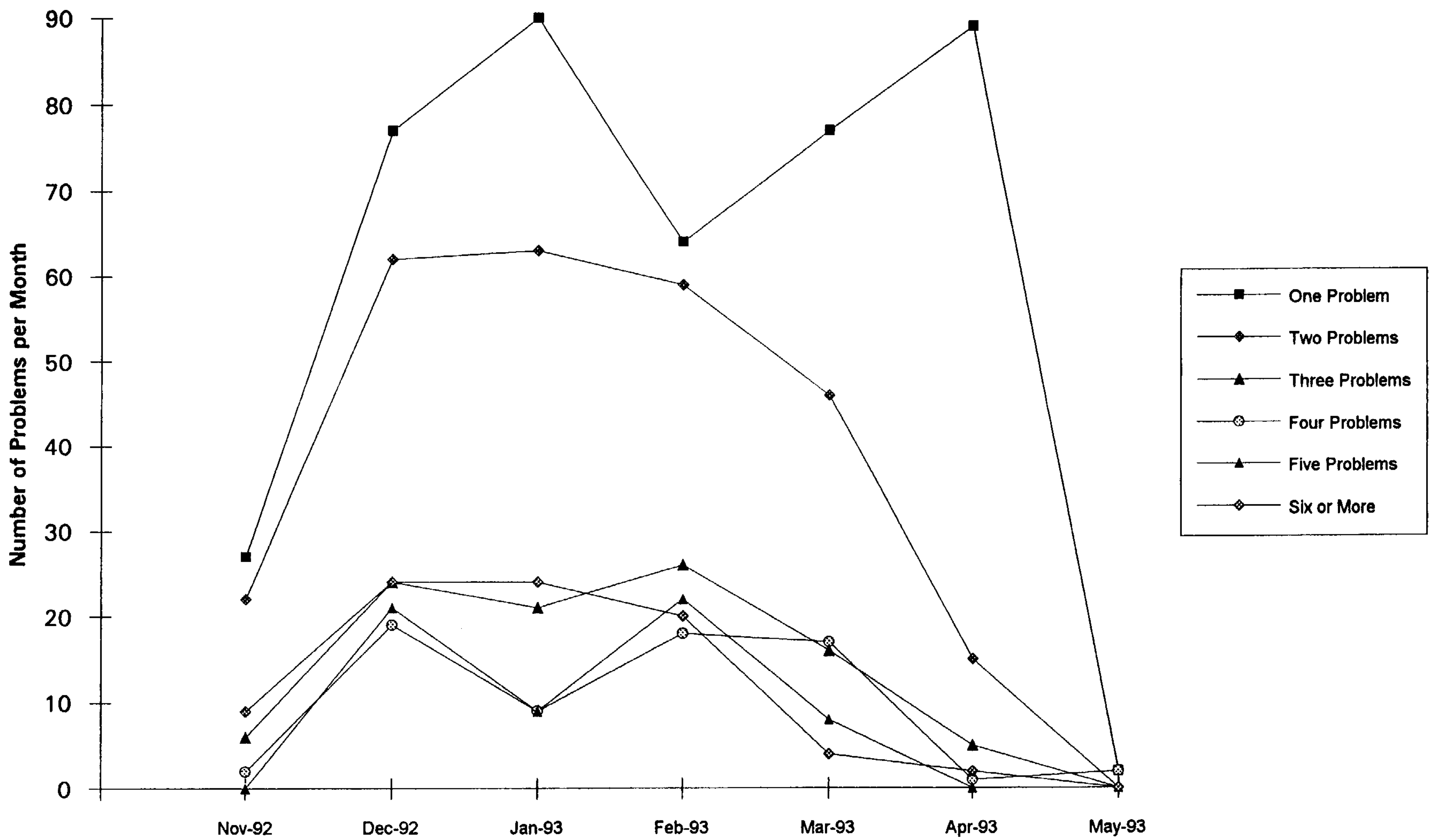


Figure 4-8. Contribution of Multiple Problem Reporting to Total Problems at El Paso

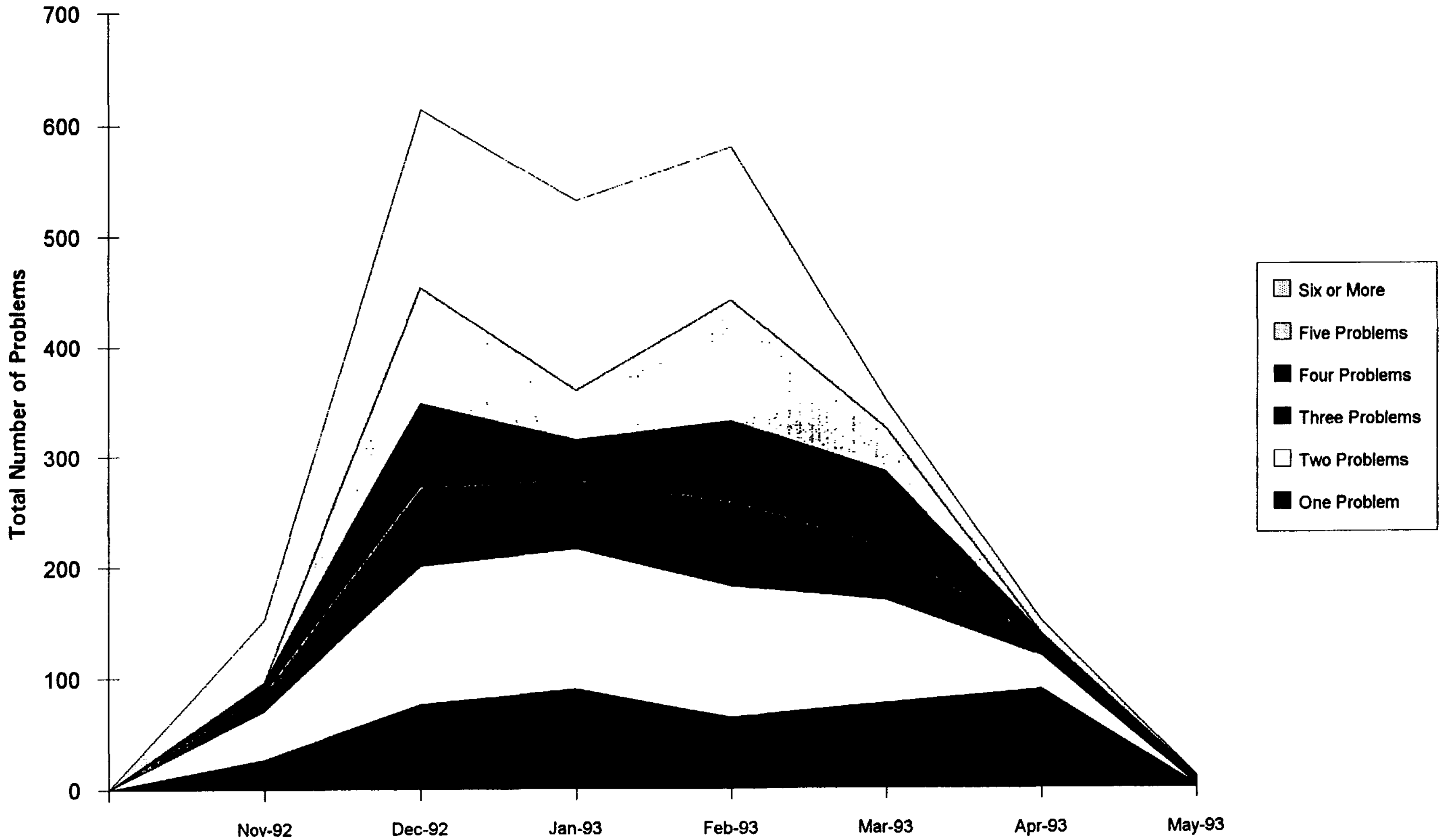


Figure 4-9. Number of Vehicles Experiencing Problems per Vehicle Operation

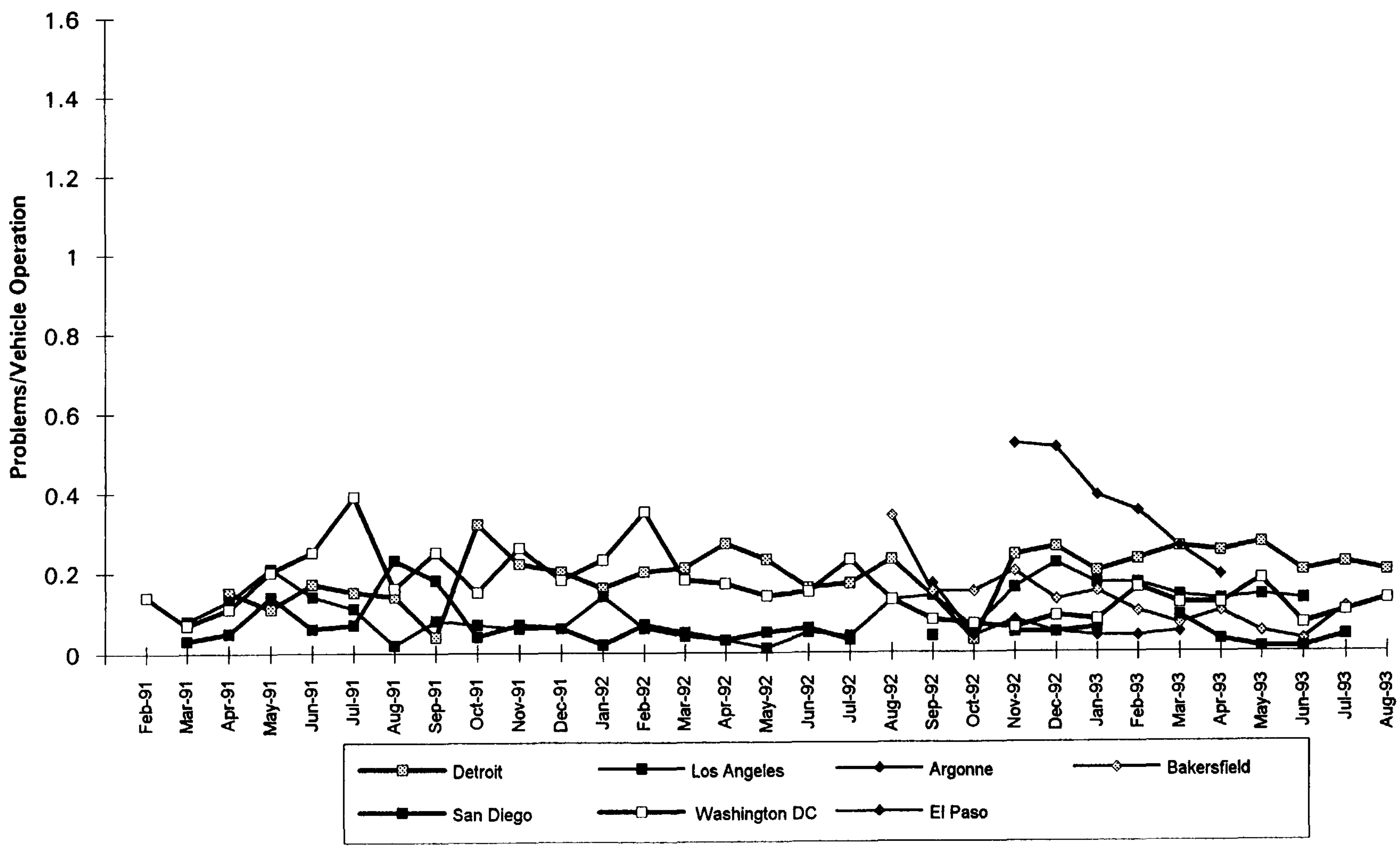


Figure 4-10. Problems Reported at El Paso

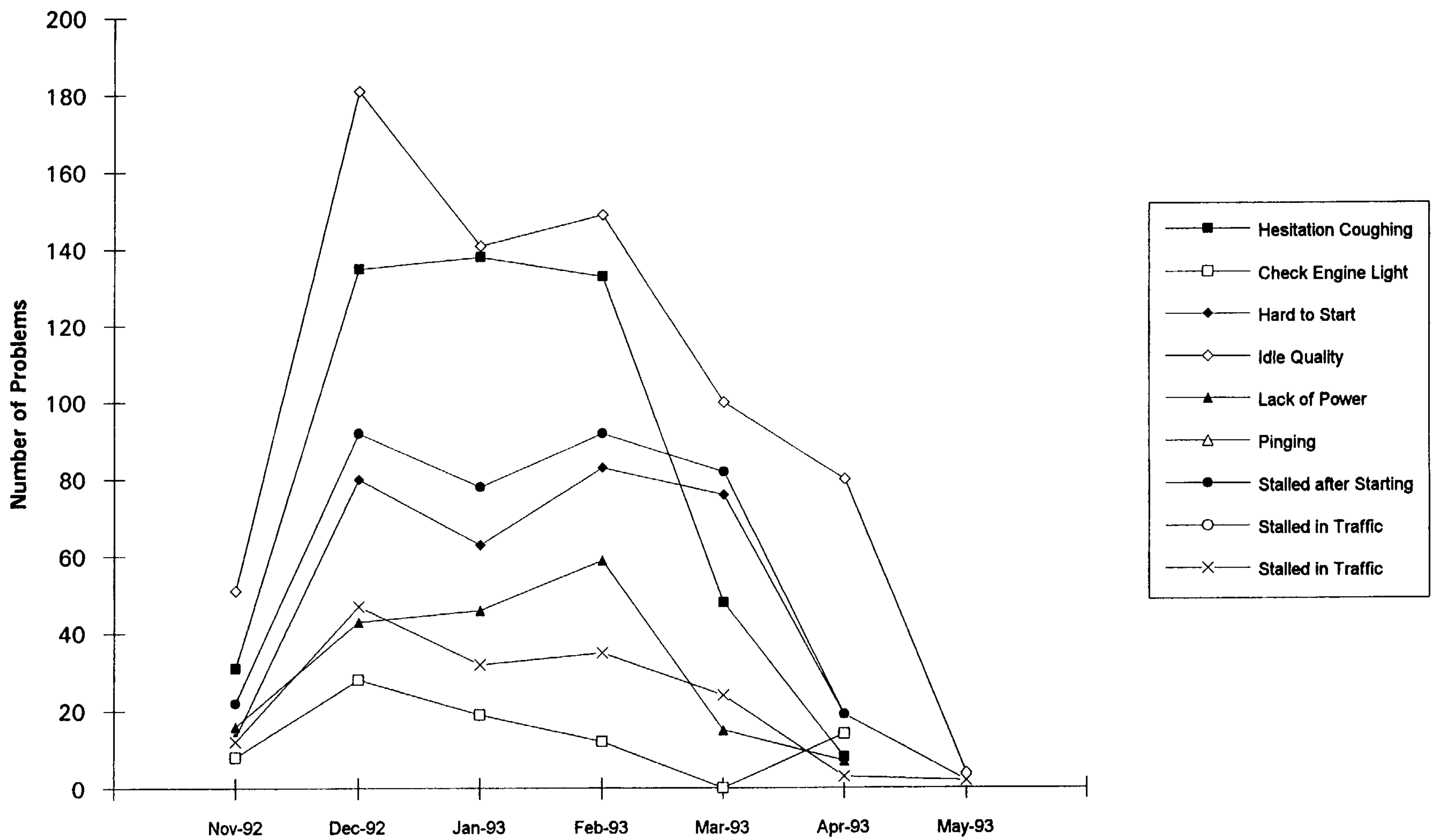


Figure 4-11. AMFA I (Methanol - Vehicles) Reported Repairs

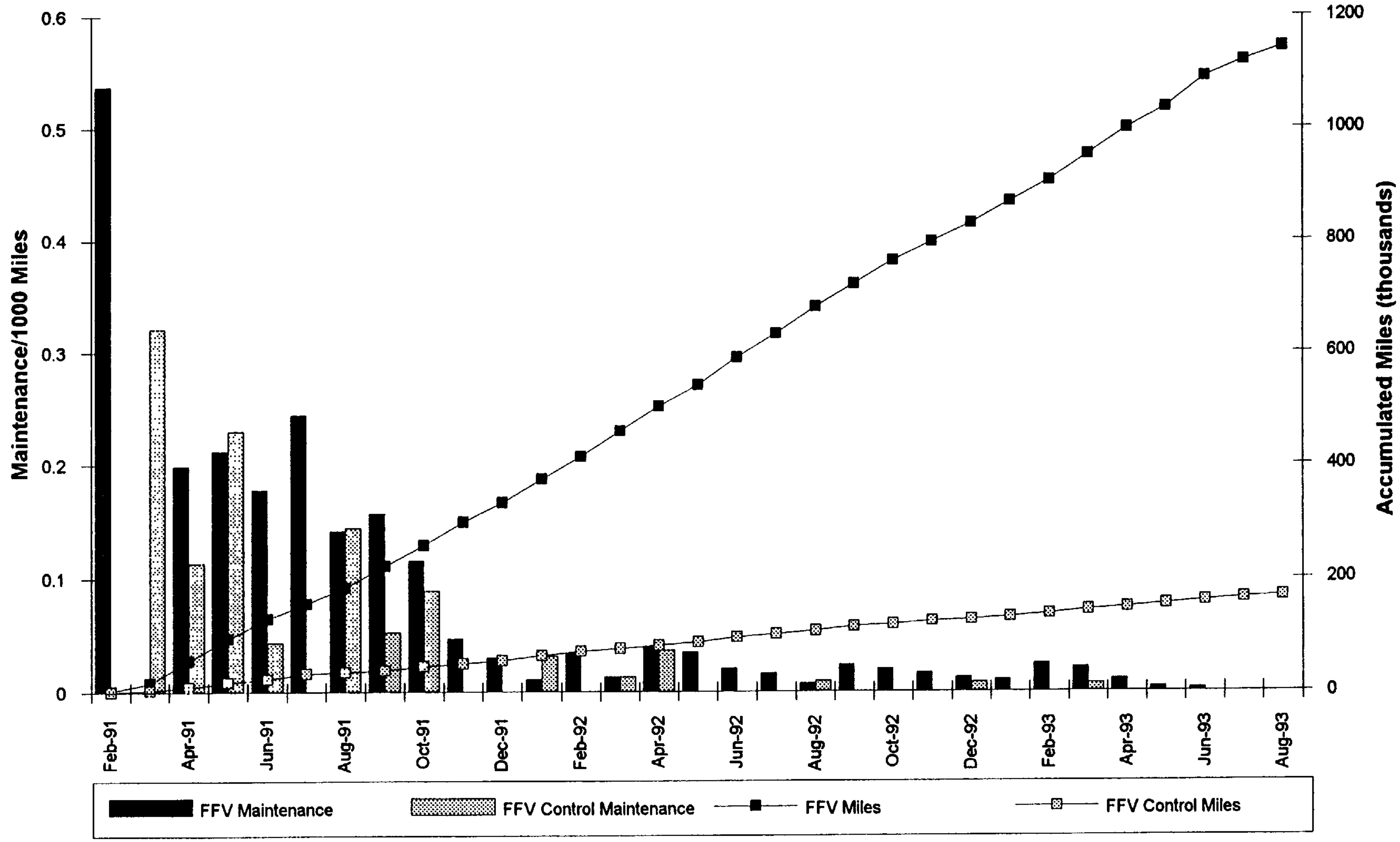


Figure 4-12. AMFA I (Control Vehicles) Reported Repairs

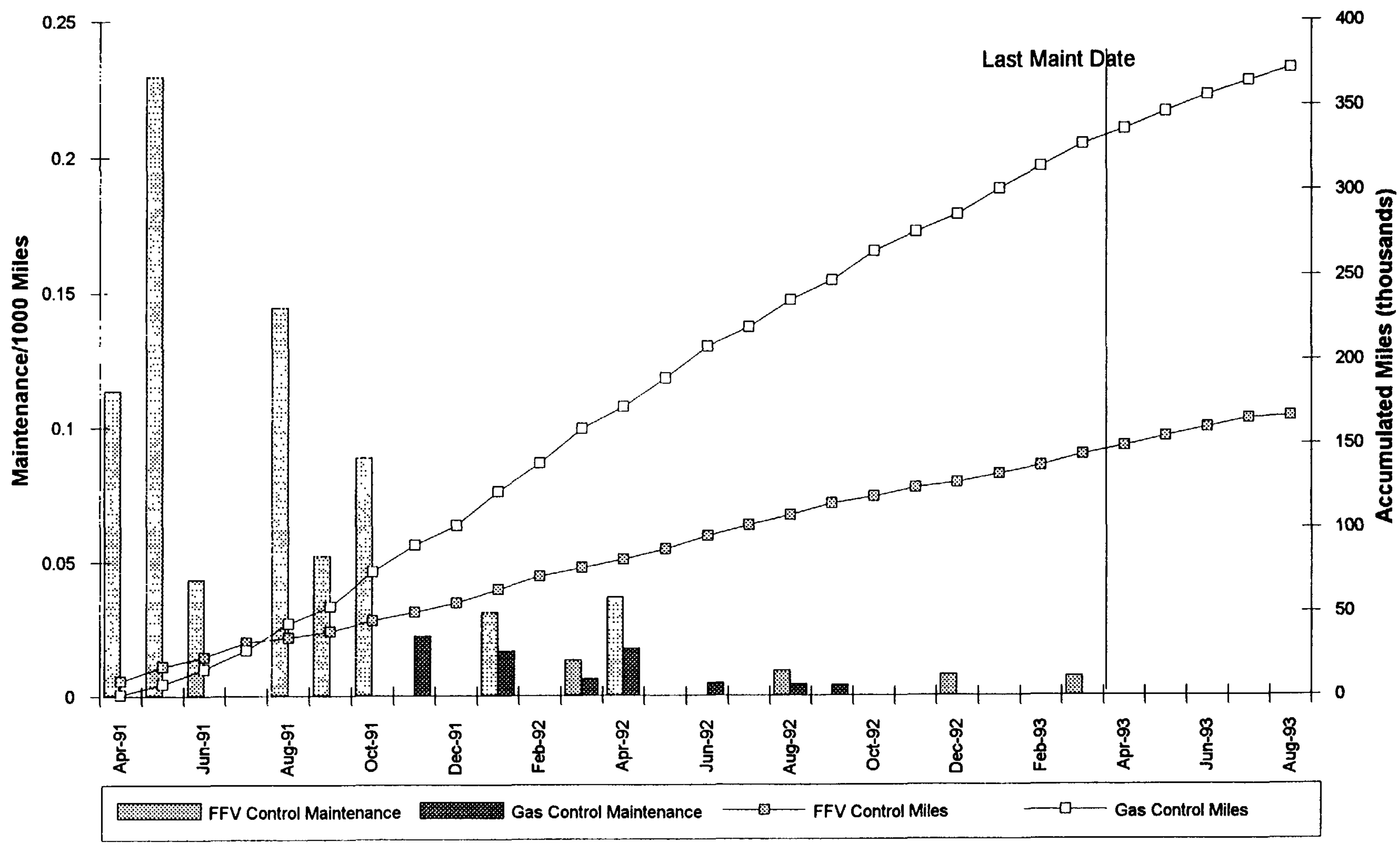
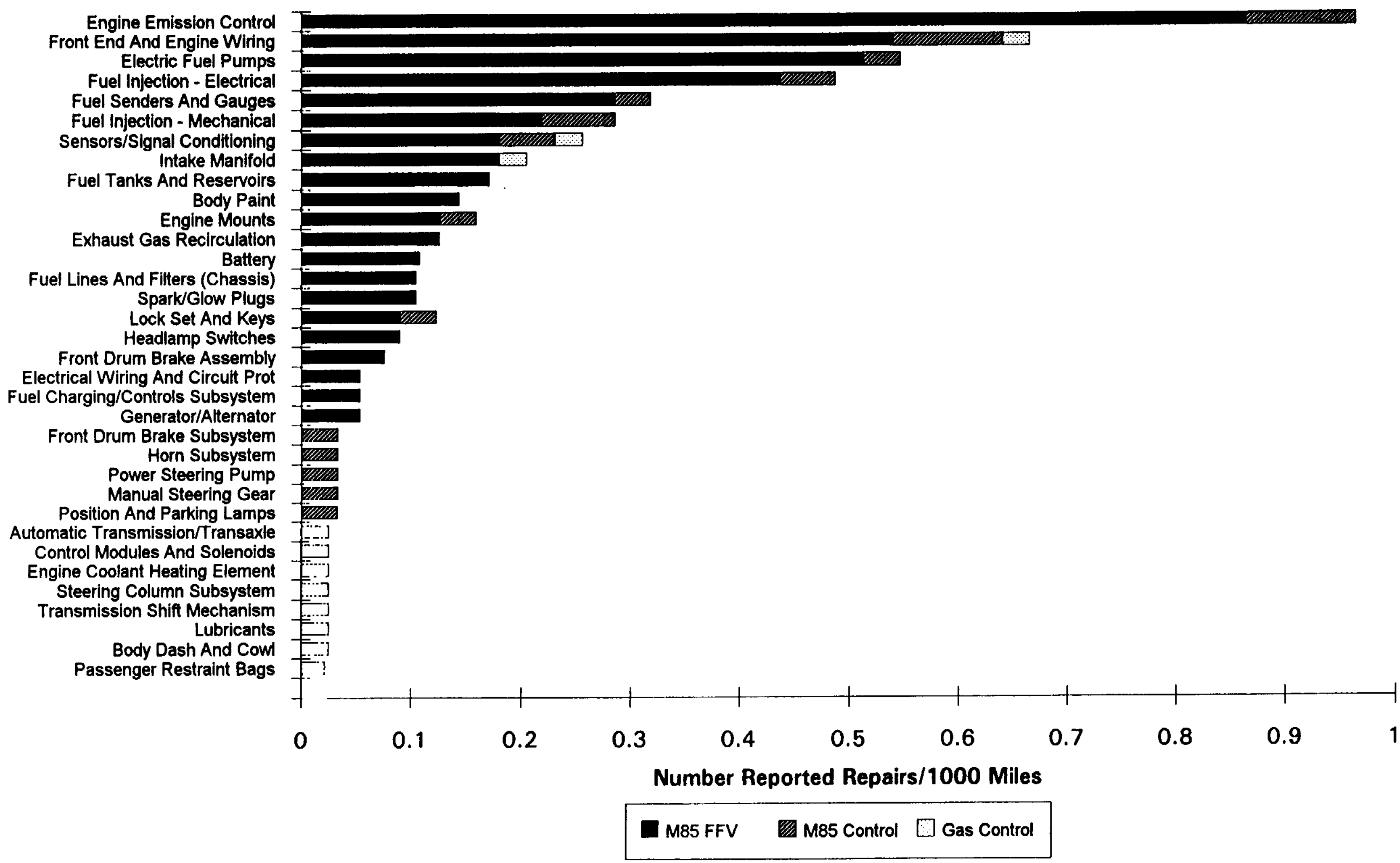


		Table A.5-5							
	Emissions Highway Cycle Test Results Used in this Analysis								
Decal ID	Test Date	Odometer	Lab	Fuel	MPG	CO, g/mi	NOx, g/mi	THC, g/mi	OMHCE, g/mi
DT003ML	6/18/92	11152	EPA1	M85		0.443	0.323	0.009	0.009
DT003ML	6/19/92	11195	EPA1	M85		0.318	0.339	0.008	0.008
DT004ML	7/26/91	1622	EPA1	M85	20.17	0.329	0.013	0.003	0.004
DT004ML	1/17/92	4933	EPA1	M85	20.4	0.538	0.059	0.008	0.009
DC003ML	5/14/93	23698	ERD	M85	20.9779	1.2149	0.4881	0.008	0.0101
DC003ML	5/17/93	23738	ERD	M85	20.9	1.3385	0.4997	0.0108	0.0123
DT004ML	5/18/93	1138.1	EPA1	M85	17.2	0.787	0.16	0.004	
DT004ML	5/20/93	11429.4	EPA1	M85	17.1	1.632	0.143	0.012	
DC011MT	3/3/92	4344	ERD	M85	20.2697	0.12215	0.13992	0.01467	0.01477
DC011MT	3/4/92	4382	ERD	M85	20.6158	0.06315	0.0844	0.00432	0.00611
DT006MT	6/7/91	174	EPA1	M85	19.05	0.217	0.013	0.026	0.026
DT006MT	6/11/91	233	EPA1	M85	19.34	0.124	0.007	0.014	0.014
DT006MT	3/25/92	3304	EPA1	M85	19.87	0.094	0.005	0.005	0.005
DT007MT	3/27/92	4193	EPA1	M85	20.64	0.05	0.046	0.001	0.004
DC011MT	3/15/93	9621	ERD	M85	19.9021	0.3797	0.0903	0.0102	0.0125
DC011MT	3/16/93	9660	ERD	M85	19.94	0.341	0.056	0.0098	0.0114

Figure 4-13. AMFA I (Methanol) Most Frequently Reported Repairs



Section 5.0 Emissions Analysis

The emissions performance of alternative fuel vehicles (AFVs) is a very important element of the evaluation of the future impact of this technology. To properly assess emissions from any vehicle a complete dynamometer test using known fuels and a comparable test cycle such as the Federal Test Procedure (FTP) or the EPA highway cycle must be conducted. Control vehicles, which are standard model vehicles not designed for alternative fuels, are also tested. The comparison of new alternative fuels and technology with currently accepted gasoline fuels on conventional vehicles is important to determine whether alternative fuels will help or hinder the environment.

Extensive tests have been conducted over the last two years on AMFA I M85 vehicles and their corresponding control vehicles. The following is an assessment of that data. In addition, three tests have been completed on some AMFA II dedicated CNG Chevrolet C-2500 pickups. This data has been included here, but because there is so little data and no control vehicle data, little analysis can be performed at this time

5.1 Dynamometer Emissions Measurements of AMFA I M85 and Control Vehicles

Since 1991, 127 dynamometer tests have been conducted on 18 AMFA I vehicles, including Taurus and Lumina M85 flexible fuel vehicles (FFVs) and standard control vehicles. Three laboratories--EPA, Ann Arbor, MI; EPA, Research Triangle Park, NC (operated by ManTech, Inc.); and Environmental Research and Development, Gaithersburg, MD--have conducted the tests. Table 5-1 lists the number of each of these test performed.

Several "other fuels" (three alternative fuels [methanol and ethanol blends] and seven gasolines) were tested as part of a special study sponsored by the Alternative Fuel Utilization Program and conducted by EPA by ManTech. These tests were described by Black and Gabele 1992 and will not be discussed further here. Of prime interest in this report will be the tests using indolene or certified unleaded gasoline and M85 (85% methanol and 15% unleaded gasoline) fuels. One other fuel, M50 (50% methanol and 50% unleaded gasoline), was run a few times by EPA, Ann Arbor, and will not be discussed here. Speciated emissions, measured by gas chromatography on individual bag samples, are available from some of the tests. Analysis of these data will be included in the next report.

For details of the dynamometer test cycle and the vehicle preparation performed when a vehicle is received for testing or between differing fuels, refer to Black 1991 and Black and Grable 1992. Those papers describe the procedures used at the EPA-Mantech laboratory and are typical of procedures used at the other two laboratories involved.

The following is a summary of the results of testing two fuels (indolene and M85) on six vehicle types, three Luminas and three Tauruses using two test cycles, the FTP and the Highway Cycle (HWFET). The Taurus /FFVs are emission-exempt, while the Lumina VFVs are EPA certified. Because of this difference in their design, Tauruses and Luminas will not be compared against each other. Generally, three emissions gases are reviewed: CO (carbon monoxide), NO_x (oxides of nitrogen) and THC (total hydrocarbons). In the case of alcohol fuel, OMHCE (organic material hydrocarbon equivalent) is substituted for THC. OMHCE adds a contribution from the methanol and formaldehyde in the exhaust to the total hydrocarbon present. In addition, because formaldehyde (HCHO) is a toxin and of considerable interest, it is also reviewed. Several other gases were measured in some of the tests but no consideration was given to them in this analysis. Only weighted (averages of several samples during the test) results for the FTP test will be analyzed. Additional data on the concentrations of emission gases in each sample are housed in the data base at the AFDC.

This analysis attempts to study the effect of vehicle mileage on the amount of each species emitted and compares (1) three types of Luminas, all operating on indolene, (2) Lumina variable fuel vehicles (VFVs) operating on indolene and M85, (3) three types of Tauruses, all operating on indolene, and (4) Taurus FFVs operating on indolene and M85. An attempt is made to look for systematic errors made by one lab or another. Also, where possible, an attempt was made to determine the impact of maintenance. Maintenance, if the records are complete, can indicate two things: (1) if the vehicle is properly maintained to give optimum emission, or (2) has the vehicle required maintenance indicating that it has had problems that may have damaged the catalyst?

5.1.1 Summary of Results

FTP CO Emissions. For Luminas operating on indolene, the standard vehicle had very high emissions, generally greater than the EPA limit of 3.4 g/mi. The VFV emissions were lower on indolene. The VFV Lumina operating on M85 was twice as high as the same vehicle on indolene and exceeded the EPA limit by 12,000 vehicle miles.

The Tauruses were different: the standard vehicle on operating indolene was well below the EPA limit, while the FFVs far exceeded the EPA limit. The CO emissions of the FFVs operating on M85 were also much higher than the EPA limit, but were less than when using indolene fuel.

FTP NO_x Emissions. The standard Lumina operating on indolene was well below the EPA limit of 1 g/mi. The Lumina VFVs operating on indolene were below the EPA limit, but were tending toward it and may exceed it by 20,000 vehicle miles. The NO_x emissions of the VFV Lumina operating on M85 were considerably lower as would be expected for an alcohol fuel, which tends to operate at a lower combustion temperature, keeping the NO_x formation lower.

There was little difference in the different Taurus models even when operating different fuels. All hovered around 0.4 g/mi.

FTP THC and OMHCE Emissions. The standard Lumina operating on indolene was greater than the EPA limit of 0.41 g/mi. The Lumina VFVs using indolene emitted less THC than the EPA limit. The VFV when operated on M85 was even lower than on indolene.

The standard Taurus operating on indolene was much lower than the EPA limit at about 0.2 g/mi. The Taurus FFVs operating on indolene were much higher and tending toward the EPA limit, probably by 25,000 vehicle miles.

HWFET Emissions. As expected, the emissions using the highway test cycle are much lower than those measured in the FTP test cycle (city cycle). Interestingly, the comparisons of control vehicle and AFV emissions operating on indolene or of AFV operating on indolene and M85 were almost all identical to the comparisons of the FTP data. This reinforces the FTP comparisons, some of which were made with highly scattered data, resulting from a quite different test.

Indications of Laboratory Differences. No actual lab correlation studies were completed using the same vehicle at all labs. However, in looking at the results from the different laboratories, the data is well mixed and no laboratory stands out as having consistently high or low results.

Indications of Burned Out Catalysts. In reviewing the maintenance performed on the vehicles and the emissions measured, there does not seem to be an no indication that contaminated fuel caused enough engine problems to burn out any catalysts. However, additional, specific catalyst efficiency tests should be performed to verify this.

5.1.2 FTP Test Cycle - CO Results

Figures 5-1, 5-2, and 5-3 illustrate the weighted (based on three samples; see AFDC data base for individual sample values from each test; see also Black 1991) CO emissions results of the FTP cycle dynamometer tests conducted on several 1991 Taurus and 1991 Lumina vehicles. The relationship of CO emissions and mileage was fit to a linear equation. The parameters for those equations and their goodness of fit are given in appendix A.5. The vehicles tested included standard, unleaded gasoline-only vehicles and variable or flexible fueled models. The latter are capable of operating on mixtures of M85 and unleaded gasoline. Additionally, the variable/flexible fuel vehicles include control vehicles that operate and are tested only on unleaded gasoline.

Different Luminas Operating on Indolene. All data for this category show increasing emissions with increasing vehicle mileage. In the case of the standard vehicle, emissions are generally higher than those from the VFVs when they are operating on indolene. Many of the standard vehicle results are above the EPA maximum allowable limit of 3.4 g/mi (see Figure 5-1). The control VFVs are about the same as the non-control VFVs for indolene and are lower than the standard Lumina. The VFVs are generally below the 3.4 g/mi limit when operating on indolene.

VFV Luminas Operating on Indolene and M85. A comparison of Figure 5-1 and 5-3 shows that there is considerable scatter in the M85 data, but that the M85 CO emissions are higher than for the same VFVs operating on indolene. The difference when operating on M85 is slight but noticeable at low mileage and is nearly twice as high at 25,000 miles, approximately 4.5 g/mi on M85 versus 2.2 g/mi on indolene.

As an aside, General Motors is aware of these test results and has requested and taken three VFV 1991 Luminas to their EPA-certified emissions laboratory for further FTP cycle testing. The results of their testing and subsequent discussions between NREL, GM, and the original testing laboratory will be included in the next report.

Different Tauruses Operating on Indolene. The Taurus results are significantly different then those for the Luminas. One fundamental difference is that the Taurus FFVs are emissions exempt. Therefore, they are not required to meet the EPA emissions standards. The data reflect this. For indolene fuel, the FFV Tauruses show significantly higher CO emissions than the standard Taurus model. The standard Taurus (see Figure 5-2) averages between 2 and 3 g/mi CO, over the entire range of testing to 25,000 miles. The FFV Tauruses start out at low mileage with less than 3.4 g/mi CO, but by 10,000 miles are clearly above 3.4 g/mi, with values in the 4 to 6 g/mi CO. There does not appear to be a difference between the Taurus FFVs that have been running on M85 in the field and the Taurus FFVs (controls) that have always been running on unleaded gasoline (see Figure 5-2).

FFV Tauruses Operating on Indolene and M85. The FFV Tauruses tested on M85 (the same FFVs that were tested on indolene, except that no FFV control vehicles were tested on M85) showed lower CO emissions. The data (see Figure 5-3) show an increase in emissions with mileage but the results are well below those measured while operating on indolene. The FFVs on M85 ranged from less than 2 g/mi at very low mileage to just less than 5 g/mi at 15,000 miles. The results from these vehicles operating on indolene averaged about 5 g/mi at 10,000 miles. It should be noted that there are more M85 data and they are well correlated with mileage. The indolene results are more scattered and additional data may change the above conclusion.

Ford is aware of these results and is currently reviewing the data. Ford representatives stress that the FFV are emissions exempt and that they would not expect them to perform as well as the emissions-certified, standard, unleaded, gasoline-designed Taurus. They are also concerned that all of the bad M85 fuel around the country may have damaged the catalysts on some FFVs (see the section on Maintenance). Their explanation is that impurities in the fuel, caused by dispenser materials of construction incompatibles with M85, may have caused injectors to fail open, sending an very rich exhaust stream to the catalyst. This fuel-rich exhaust could burn out a catalyst. There is evidence (fuel injector and fuel pump replacements) that the fuel has been a problem, but no direct evidence that a catalyst has been damaged. The above comparison (see Figure 5-2) of CO emissions from FFV controls (which have never burned M85) and FFVs (which have operated on M85 in the field) shows no difference. This issue will be revisited in the maintenance section.

Lab Correlations. No direct lab correlation (where the same vehicle was taken from lab to lab and run on each dynamometer) study has been performed with these test vehicles and laboratories. However, a crude comparison of results is shown in Figures 5-1, 5-2, and 5-3. The various laboratories making the measurements are shown as different shades. The Lumina indolene results are well mixed, with the exception of one data point from EPA-ManTech. The Taurus indolene results are also well mixed. The M85 results are mixed, but probably not significantly different. The EPA-Ann Arbor tend results to be lower and the EPA-ManTech results appear to be a little higher.

5.1.3 FTP Test Cycle - NO_x Results

The same FTP cycle tests generate data on NO_x emissions. Again, only the weighted results will be considered here. Figures 5-4, 5-5, and 5-6 illustrate the NO_x results for 1991 Tauruses and 1991 Luminas. The types of vehicles include standard unleaded gasoline only vehicles and VFVs/FFVs capable of operating on any blend of unleaded gasoline and M85. Tests were conducted on indolene (certified unleaded gasoline) and M85. As with CO emissions, NO_x emissions generally tend to increase with increased vehicle mileage. One possible exception is Lumina VFV control vehicles, which have some lower values at high mileage.

Different Luminas Operating on Indolene. Generally, NO_x emissions tend to increase with mileage. VFV control vehicles are an exception. A total of seven tests was conducted on two different vehicles by two laboratories. On each individual vehicle, the emissions increased with mileage. In this case there is a difference between labs or vehicles that has skewed the correlation line in a different direction (see Figure 5-4). Operating on indolene, the standard Lumina had generally lower NO_x emissions than the VFV Lumina, with the exception of one vehicle (DC005MLC). The current EPA certification standard for NO_x is 1.0 g/mi on the FTP cycle. All data measured on these two fuels are less than that limit. However, the trend of the VFV Luminas is steadily upward and could exceed the limit at higher mileages (greater then 30,000 miles). One of the VFV controls is low, but the other is about the same as other VFVs.

VFV Luminas Operating on Indolene and M85. The VFV vehicles operating on M85 show considerably lower NO_x emissions. Maximum values for indolene fuel are 0.7 to 0.9 g/mi at 10,000 to 25,000 miles (see Figure 5-4). The maximum values operating on M85 fuel are much lower at 0.5 to 0.6 g/mi at 10,000 to 25,000 miles (see Figure 5-6).

Different Tauruses Operating on Indolene. Again, NO_x emissions tend to increase with mileage (see Figure 5-5). The results of the standard Taurus are well correlated and range generally less than 0.3 g/mi NO_x. The FFV vehicles are more scattered both above and below that of the standard Taurus. None of the results on indolene indicates a strong enough correlation with mileage to exceed the EPA 1.0 g/mi limit on future testing.

FFV Tauruses Operating on Indolene and M85. The FFVs, when tested on M85, are generally about the same. The linear regression appears steeper, but that generally results from a single high point at higher mileage (see Figure 5-6).

Lab Correlation. As with CO data, the results are fairly well scattered and there does not appear to be a systematic difference amongst laboratories.

5.1.4 FTP Test Cycle - THC and OMHCE Results

During the FTP dynamometer test, a measurement is made for THC when using indolene fuel. When using alcohol fuels, measurements of THC, formaldehyde, and methanol are used to calculate the OMHCE. Using these measured emissions, a contribution equation is used (see Black 1991) to determine OMHCE. As with the other gases reported, only the weighted results are given here. THC and OMHCE tests results are shown in Figures 5-7, 5-8, and 5-9. Supporting emissions levels of methanol and formaldehyde are given in Figures 5-10 and 5-11.

Different Luminas Operating on Indolene. The EPA limit for THC is 0.41 g/mi. Many of the standard Lumina results are greater than this value (see Figure 5-7). As with CO, the THC emissions of standard Luminas are greater than the VFVs operating on indolene. The non-control VFV is slightly higher than the VFV control, but neither vehicle type is expected to exceed the EPA limit in the next round of tests.

VFV Luminas Operating on Indolene and M85. The OMHCE results for VFV Luminas are slightly lower than the THC of the same vehicles operating on indolene. The VFV operating on M85 had OMHCE emissions less than 0.25 g/mi, while the same vehicles on indolene were less than 0.3 g/mi.

The formaldehyde emissions, shown in Figure 5-11, also increase with mileage, but not greatly. These emissions for Luminas are less than 0.028 g/mi (28 mg/mi).

Different Tauruses Operating on Indolene. As with other emission gases, the THC from FFV Tauruses operating on indolene are considerably higher than for the standard gasoline Taurus (see Figure 5-8). The control FFV shows a steeper increase with mileage than the non-control FFV (further evidence against damaged catalysts). Both types of FFVs have exceeded the EPA limits of 0.41 g/mi, while the standard Taurus vehicles (maximum about 0.22 g/mi) are not near the EPA limit.

The Taurus FFV tested on M85 emits about the same OMHCE as THC when operating on indolene.

5.1.5 HWFET Test Cycle - CO Results

The dynamometer test laboratories, in addition to running the vehicles on the FTP cycle, also ran many highway test cycles (HWFET). The FTP approximates a form of city driving and when combined with a HWFET cycle test gives a better overview of the emissions to be expected from the vehicle. As with the FTP, six different vehicle types (see Table 5-1) were tested using two different fuels, indolene and M85. Only the emissions of CO, NO_x, and THC (or OMHCE for alcohol fuels) will be reviewed here. Additional data from these tests are included in the emissions data bases available on line from the AFDC. CO emissions from HWFET tests are summarized in Figures 5-12, 5-13, and 5-14, regression parameters and an indication of goodness of fit can be found in the appendix.

Different Luminas Operating on Indolene. Lumina VFV and VFV control vehicles tested on indolene showed very little variation with vehicle mileage. The values of CO for these vehicles on indolene are generally between 0.4 and 1.0 g/mi (see Figure 5-12). The standard unleaded gasoline-designed Lumina had several tests in this same range, but then had two tests performed at EPA-Ann Arbor that were very high (2.0 and 2.3 g/mi CO). This test was repeated one month later and the value returned to 0.74 g/mi. It must be concluded that these two points were problems at the lab and that the Lumina standard vehicles operate consistently with the VFV vehicles, with CO less than 0.8 g/mi.

VFV Luminas Operating on Indolene and M85. The same VFV non-control vehicles were also tested on M85 (see Figure 5-14). The CO values are widely scattered but are trending upward with mileage. CO emissions at 12,000 to 24,000 miles are greater than 1.0 g/mi; on indolene, they were less than 1.0 g/mi. Also, the VFV on M85 had CO emissions comparable with using indolene fuel at low mileage. This is exactly the same pattern seen in the FTP cycle (see FTP section above).

Different Tauruses Operating on Indolene. CO emissions for Taurus FFVs and FFV controls operating on indolene are shown in Figure 5-13. There is no difference between the two different vehicles. Although most of the data are low, only one point above 1.0 g/mi, the trend is upward. The standard, unleaded, gasoline-designed Taurus has low CO emissions (less than 0.2 g/mi) and is fairly steady with mileage (see Figure 5-12). The pattern seen here for Taurus CO emissions is essentially the same as in the FTP testing.

FFV Tauruses Operating on Indolene and M85. The same FFV operating on M85 shows somewhat lower CO emissions, approximately 0.3 g/mi at 12,000 miles, rather than about 0.7 g/mi at the same mileage when operating on indolene.

5.1.6 HWFET Test Cycle - NO_x Results

NO_x results from HWFET cycle test are illustrated in Figures 5-15, 5-16, and 5-17. Again, the regression parameters used for the correlation to mileage are given in Appendix A.5.

Different Luminas Operating on Indolene. The Lumina VFV control vehicles and standard designed Luminas showed very low levels of NO_x when operating on indolene and these levels do not seem to be a function of vehicle mileage. All tests on these vehicles are less than 0.2 g/mi. The non-control VFV operating on indolene shows much higher NO_x emissions and the NO_x levels are clearly increasing with increasing mileage (see Figure 5-15). The NO_x values for this type of vehicle are as high as 0.8 g/mi at about 24,000 miles. This is a similar trend to that observed in the FTP test cycle, but obviously, with lower emission values.

VFV Luminas Operating on Indolene and M85. The same VFV Lumina, operating on M85, shows similar increasing NO_x levels with increasing mileage (see Figure 5-17). The NO_x emissions are reduced with the M85 fuel, down to about 0.5 g/mi at 24,000, but are still very much higher than the non-VFV indolene vehicles.

Different Tauruses Operating on Indolene. All of the Taurus models tested using indolene on the HWFET cycle show very low NO_x emissions (see Figure 5-16). In general, they show very weak correlation with vehicle mileage and in the case of the FFVs, actually appear to be decreasing with increased vehicle mileage. This is similar to the FTP results, but with lower overall values in this HWFET testing.

FFV Tauruses Operating on Indolene and M85. The FFV Taurus operating on M85 shows a slight tendency to increase in NO_x emissions with vehicle mileage (see Figure 5-17). The values are generally lower than the same vehicles operating on indolene, reaching only about 0.1 g/mi on M85 and averaging about 0.2 g/mi on indolene.

5.1.7 HWFET Test Cycle - THC and OMHCE Results

THC emissions for indolene and OMHCE for methanol are shown for all classes of vehicles tested in Figures 5-18, 5-19, and 5-20. The results for indolene are generally consistent and low (not a function of vehicle mileage), while the M85 results are quite scattered.

Different Luminas Operating on Indolene. The THC emissions using indolene and the HWFET cycle for all three classes of Luminas are consistent and below 0.1 g/mi with one exception (see Figure 18). One test at EPA-Ann Arbor on a standard Lumina showed 0.53 g/mi THC for the HWFET. This vehicle was tested again about 6 weeks later and measured

0.085 g/mi. It was tested once again 4 weeks after that and the result was 0.046 g/mi. The one high value was an anomaly. It is safe to say that all Lumina HWFET emissions results using indolene are less than 0.1 g/mi.

VFV Luminas Operating on Indolene and M85. When operating on M85, the VFV Lumina gave much more scattered results (see Figure 5-20). The results hover around 0.01 g/mi, and go as high as 0.02 g/mi OMHCE. This compares with values hovering around 0.4 g/mi with indolene fuel. This is similar to the FTP tests, where OMHCE values for M85 were less than THC from the same vehicle on indolene. Here, however, the difference is a factor of 10 less.

Different Tauruses Operating on Indolene. The THC emissions from HWFET test using indolene on standard Taurus vehicles are low, around 0.02 g/mi, and are not a function of vehicle mileage. The non-control FFV Taurus vehicles are generally low (around 0.3 g/mi) and are not much of a function of vehicle mileage. The control FFV vehicles have data clustered about 0.04 g/mi and then a couple of tests showed above 0.1 g/mi. The trend is upward with vehicle mileage, but only based on two tests. Generally, the hydrocarbon emissions for Tauruses are low and consistent.

FFV Tauruses Operating on Indolene and M85. The OMHCE results from operating Taurus FFVs on M85 in the HWFET cycle are very low and somewhat inconsistent. The regressed trend is downward with increasing vehicle mileage, but the data are so low (0.004 to 0.016 g/mi) that the trend is probably beyond the scatter in the data.

5.1.8 Relationship of Maintenance and Emissions

Vehicle maintenance is an important aspect of proper emissions measurements. Maintenance records are gathered for all vehicles in the test program. The appendix includes a listing of all the non-trivial maintenance items reported for all the emissions vehicles tested. A summary of the FTP emissions results is also included. The maintenance records and emissions results are grouped together by vehicle in chronological order. Thus, we can see what maintenance was performed before and after each emissions measurement.

It is not possible to determine if each vehicle was kept in top notch condition between emission tests. However, all of the Washington-based AFVs had many repairs associated with the fuel and electronic control systems, perhaps indicating that they were being well maintained either by choice or necessity (the car was running well). The Washington-based standard vehicles reported no maintenance of this type. This probably indicates that the vehicles were not causing the drivers any noticeable problems. The Detroit vehicles do not show this much maintenance, although one (a Taurus) shows considerable maintenance. Further, the AFVs from Detroit that recorded no maintenance had good emissions test results. It appears, then, that the amount of maintenance did not have an effect on the final emissions results.

As mentioned above, Ford was concerned that some of its catalysts may have been burned out by contaminated M85 fuel, causing injector problems that may have sent fuel-rich exhaust to the exhaust catalyst. If there is fuel-related maintenance on vehicles in between emissions tests (indicating fuel problems) and emissions increase, this may indicate a burned out catalyst.

Only one vehicle appeared to have fuel system work between emissions tests and also saw an increase in CO emissions. That vehicle, DC011MT (VIN: 1FACP50U9MA151448) had various work done, including replacing the fuel pump. The CO emissions increased from about 2.7 g/mi on both indolene and M85 at an odometer reading of 4300 to 3.4 to 5.5 g/mi at 9.500. This could indicate that the catalyst was harmed. It should also be pointed out that all injectors were replaced on this vehicle at 3,400 miles, which was before the first emission test. This would indicate that the vehicle has seen bad fuel for its whole life, or that fuel is not the reason for the increased CO emissions.

Some of the Detroit vehicles reported some maintenance and some reported no maintenance at all. There is no evidence in the Detroit vehicle data that indicates a systematic problem in emissions, either that maintenance was lacking or that maintenance was used to correct a problem in the emissions systems.

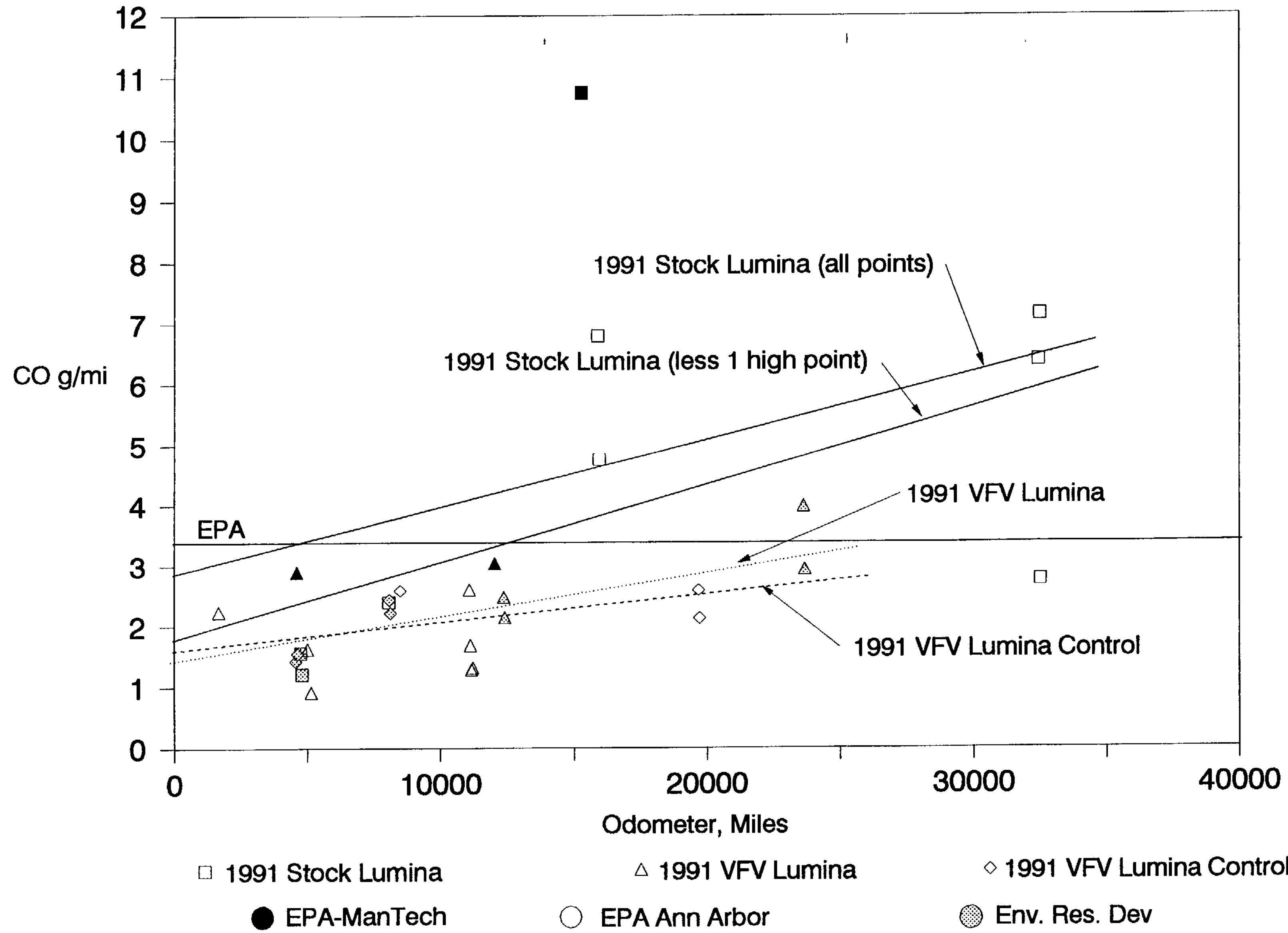
5.2 Dynamometer Emissions Measurements of AMFA II Dedicated CNG Pickups

Three dynamometer tests were completed at Southwest Research Institute in San Antonio using three dedicated CNG Chevrolet C-2500 pickups from the El Paso AMFA II site. The vehicles ranged in mileage from 4,200 to 5,200. Table 5-2 summarizes the weighted FTP and HWFET results.

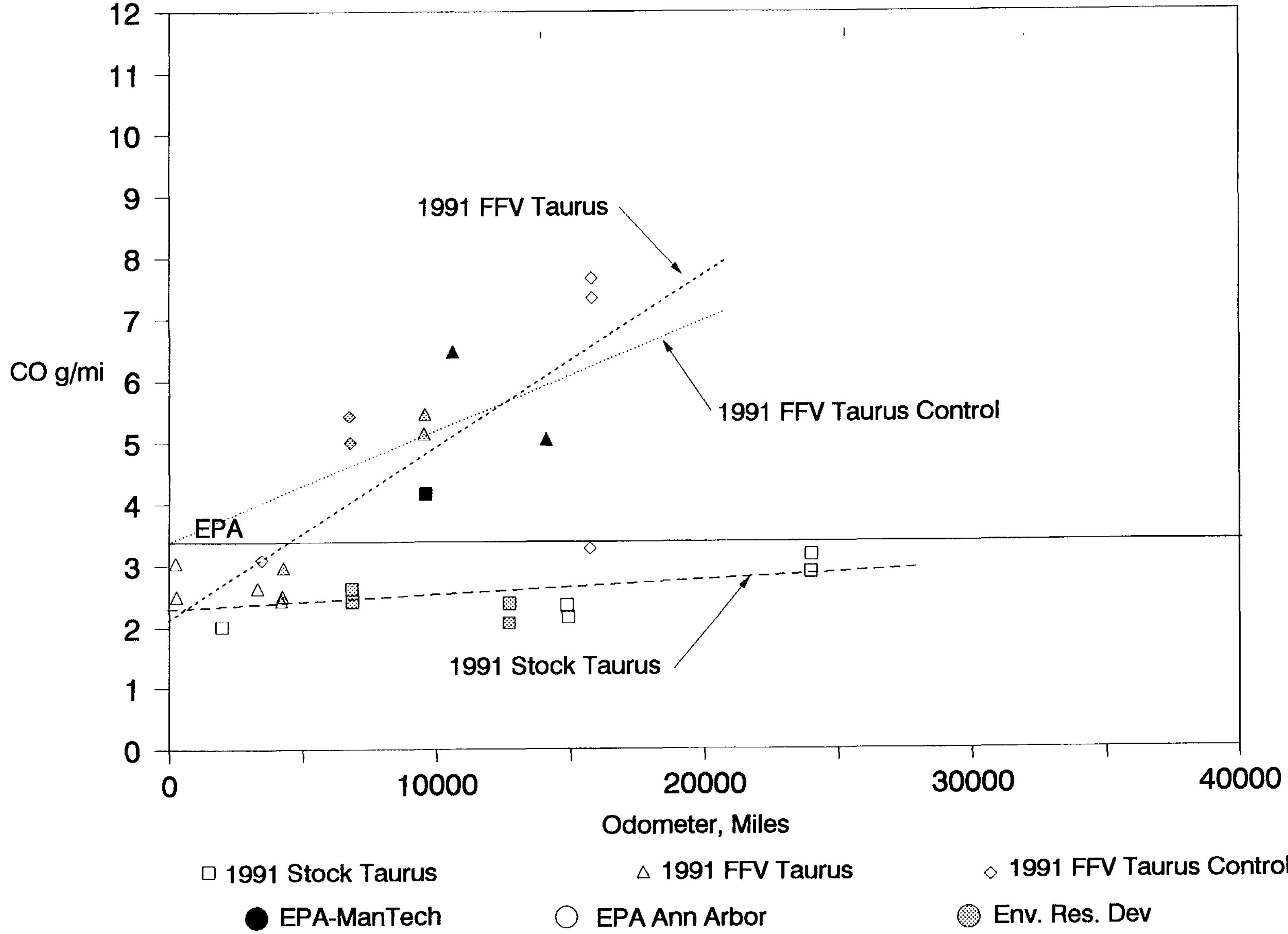
Of the regulated emissions, CO and THC were very high, but the NMHC (non-methane hydrocarbons) is extremely low and the NO_x was at a reasonable level. Specifically, the CO emissions ranged from 6.98 to 12.92 g/mi. This far exceeds the EPA limit of 3.4 g/mi. The NO_x ranged from 0.22 to 0.55 g/mi, well under the EPA limit of 1.0 g/mi. The THC, which includes methane, was 1.17 to 1.9 g/mi, which exceeds the normal EPA limit of 0.41 g/mi. The NMHC on the other hand ranges, from 0.03 to 0.076 g/mi, which is very low.

As stated earlier, more data is needed and will be arriving soon. A comparison with gasoline control pickups will also be forthcoming.

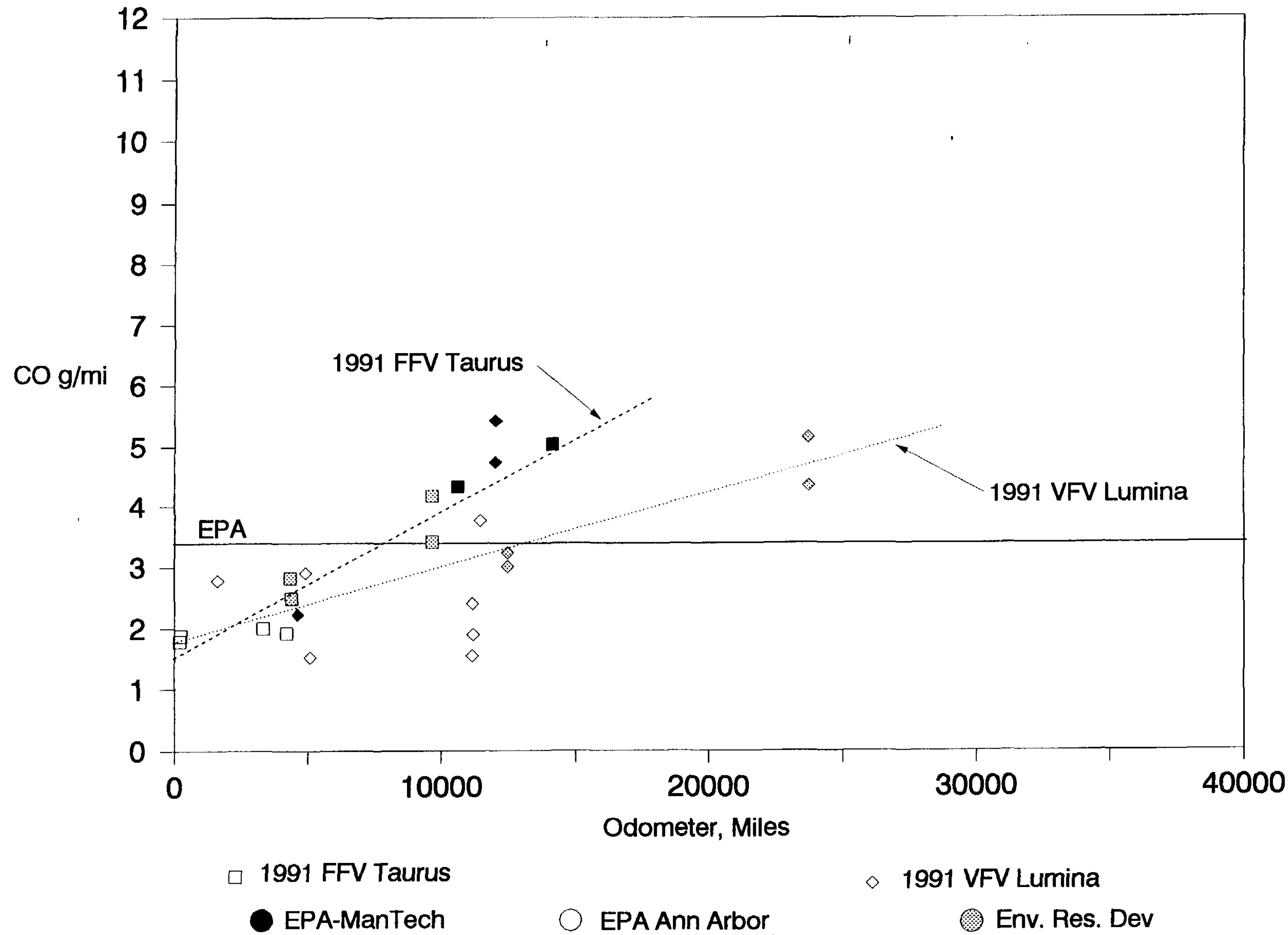
FTP Weighted Results
Exhaust CO - Indolene Fuel
Various 1991 Chevrolet Luminas
Figure 5-1

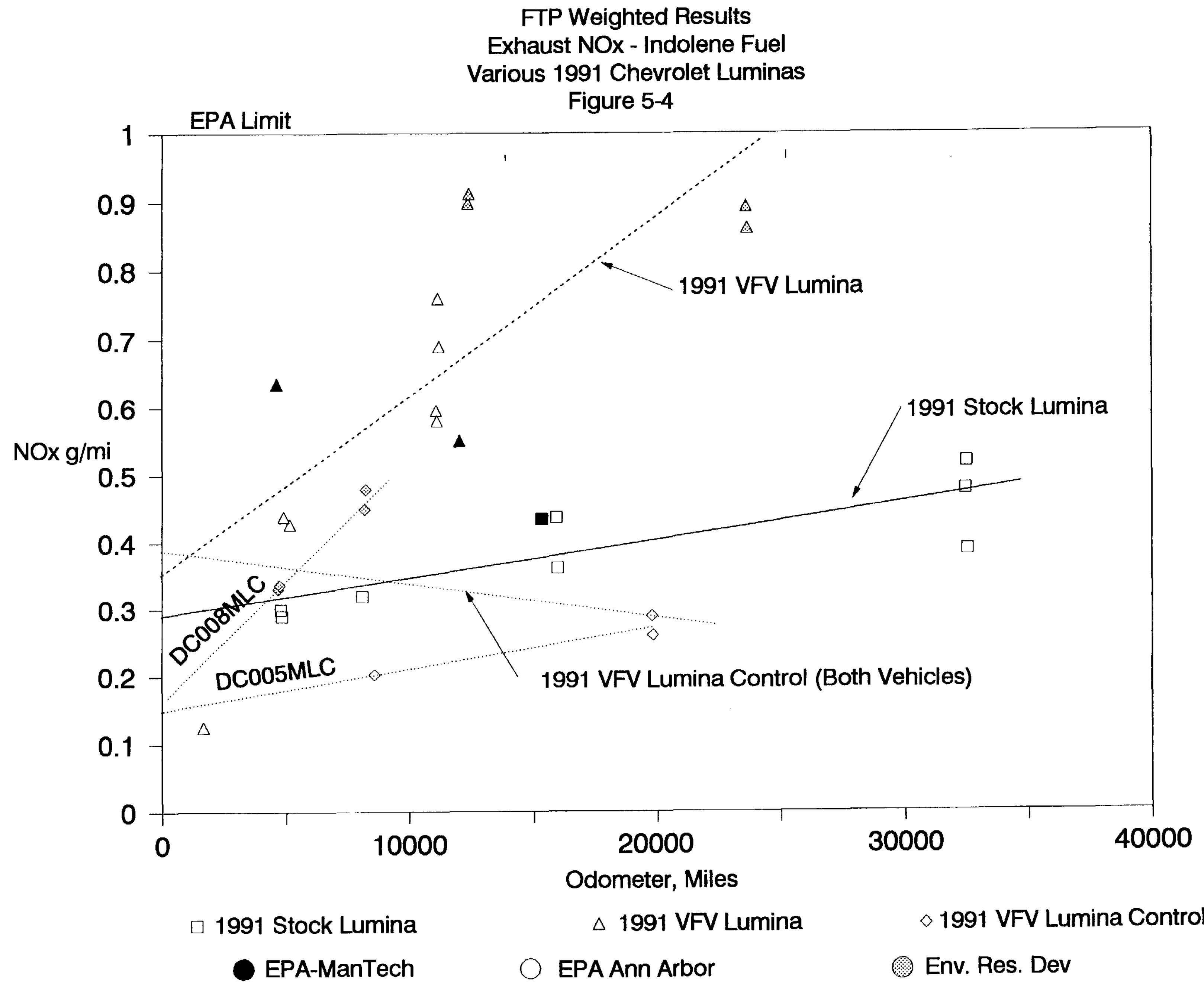


FTP Weighted Results
Exhaust CO - Indolene Fuel
Various 1991 Ford Tauruses
Figure 5-2



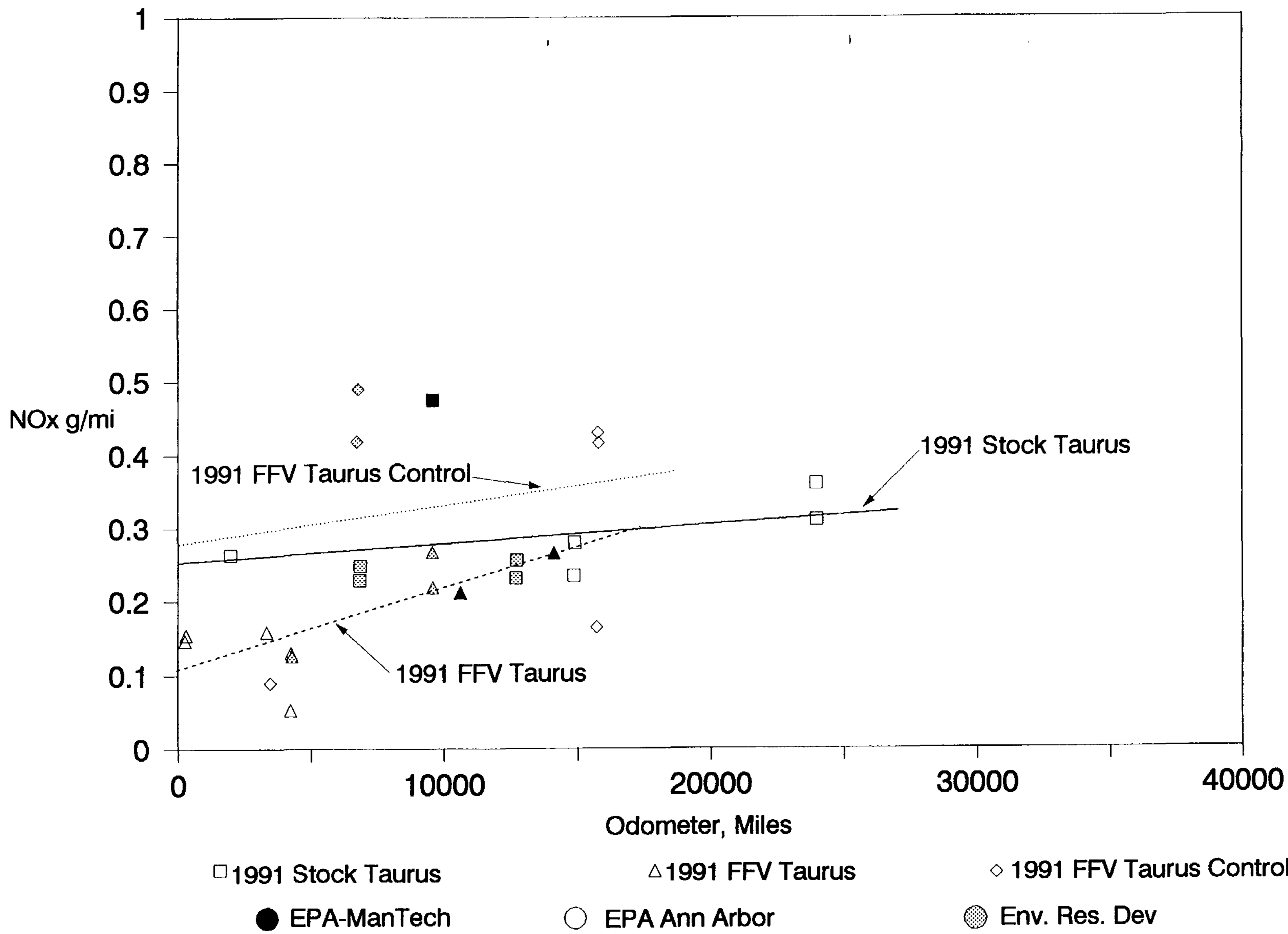
FTP Weighted Results
Exhaust CO - M85 Fuel
Flexible Fueled 1991 Ford Tauruses & 1991 Chevrolet Luminas
Figure 5-3



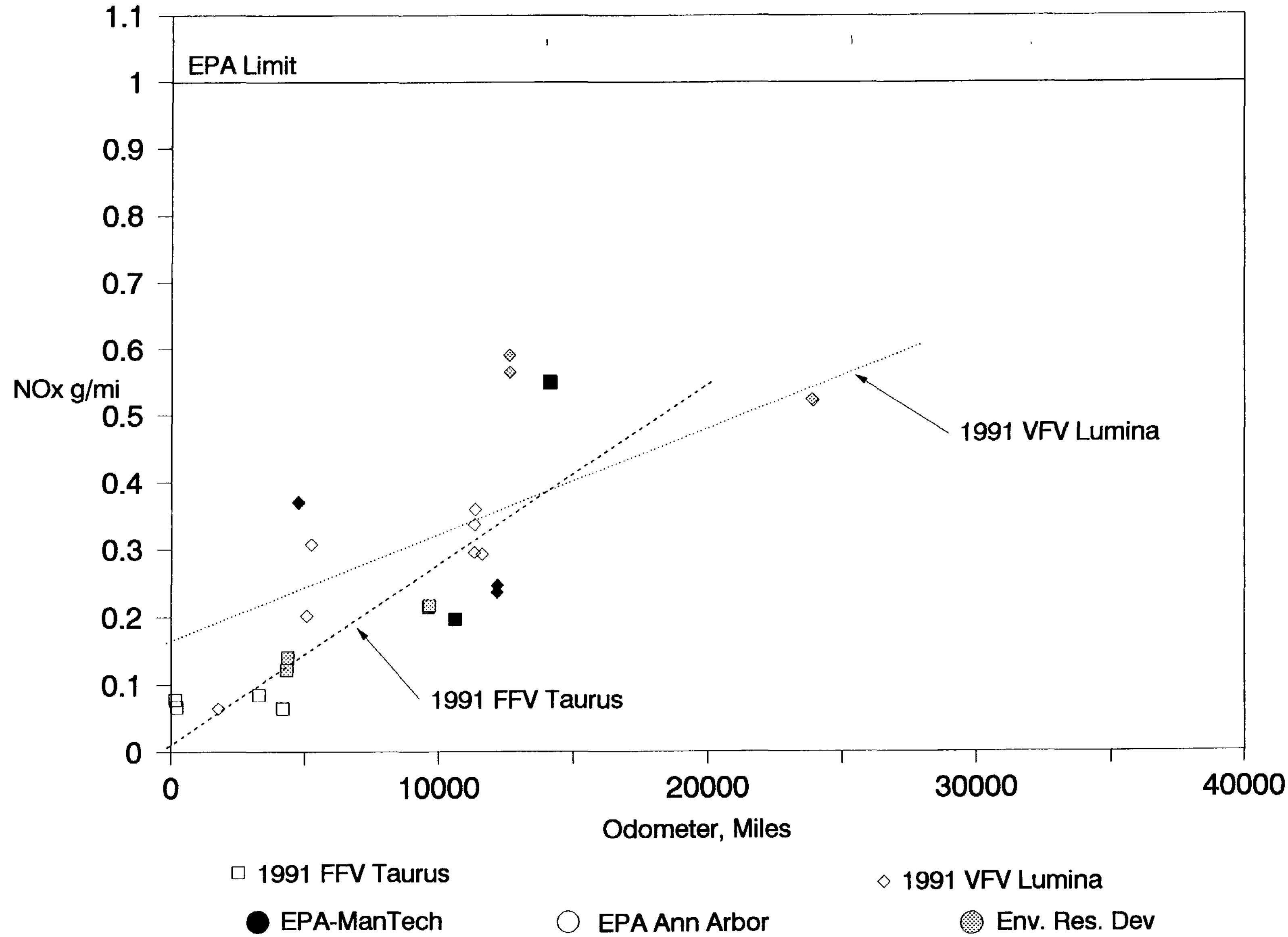


FTP Weighted Results
Exhaust NOx - Indolene Fuel
Various 1991 Chevrolet Luminas
Figure 5-4
EPA Limit
NOx g/mi
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1991 VFV Lumina
1991 Stock Lumina
DC008MLC
DC005MLC
1991 VFV Lumina Control (Both Vehicles)
0
10000
20000
30000
40000
Odometer, Miles
1991 Stock Lumina
1991 VFV Lumina
1991 VFV Lumina Control
EPA-ManTech
EPA Ann Arbor
Env. Res. Dev

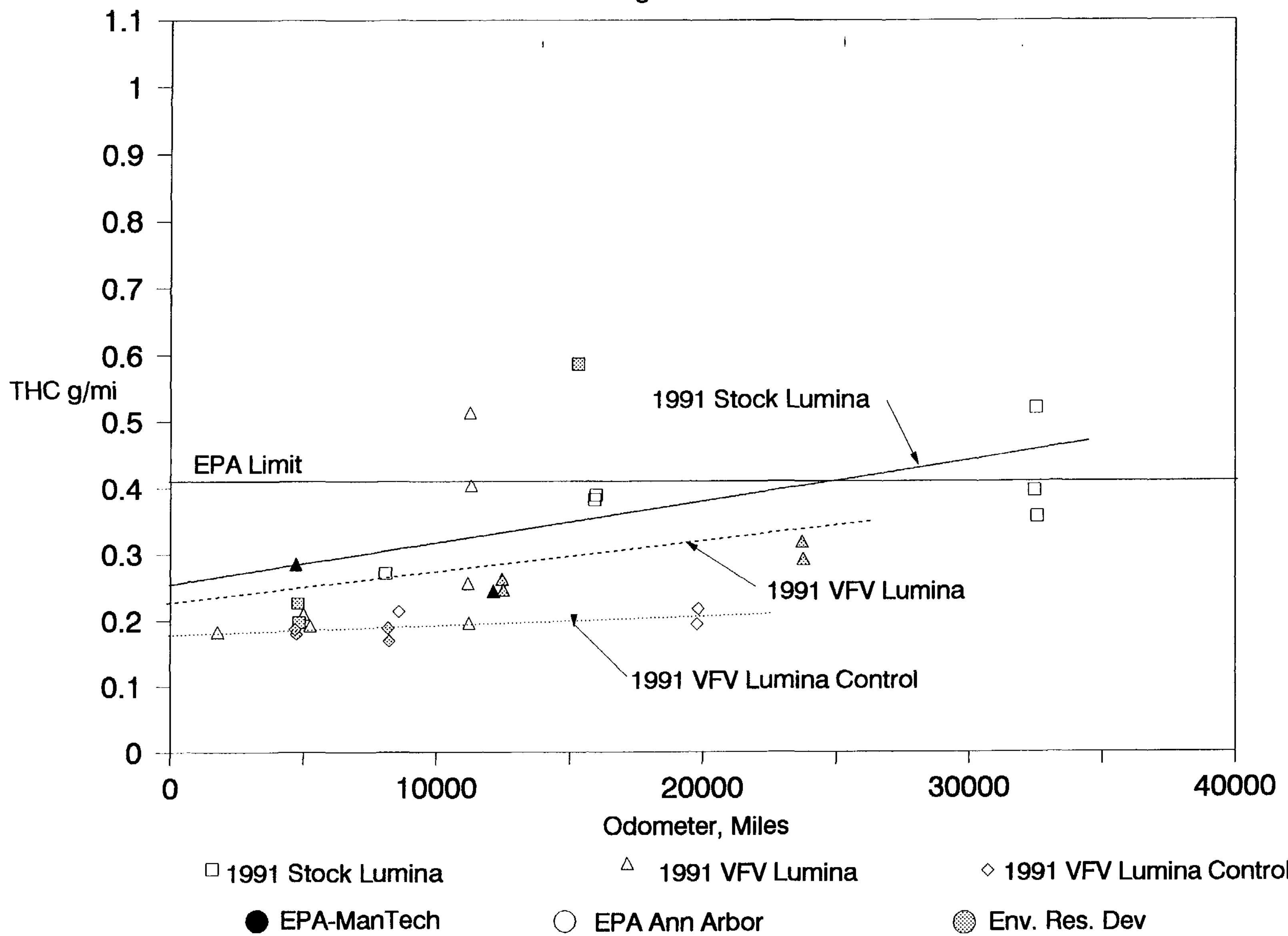
FTP Weighted Results
Exhaust NOx - Indolene Fuel
Various 1991 Ford Tauruses
Figure 5-5

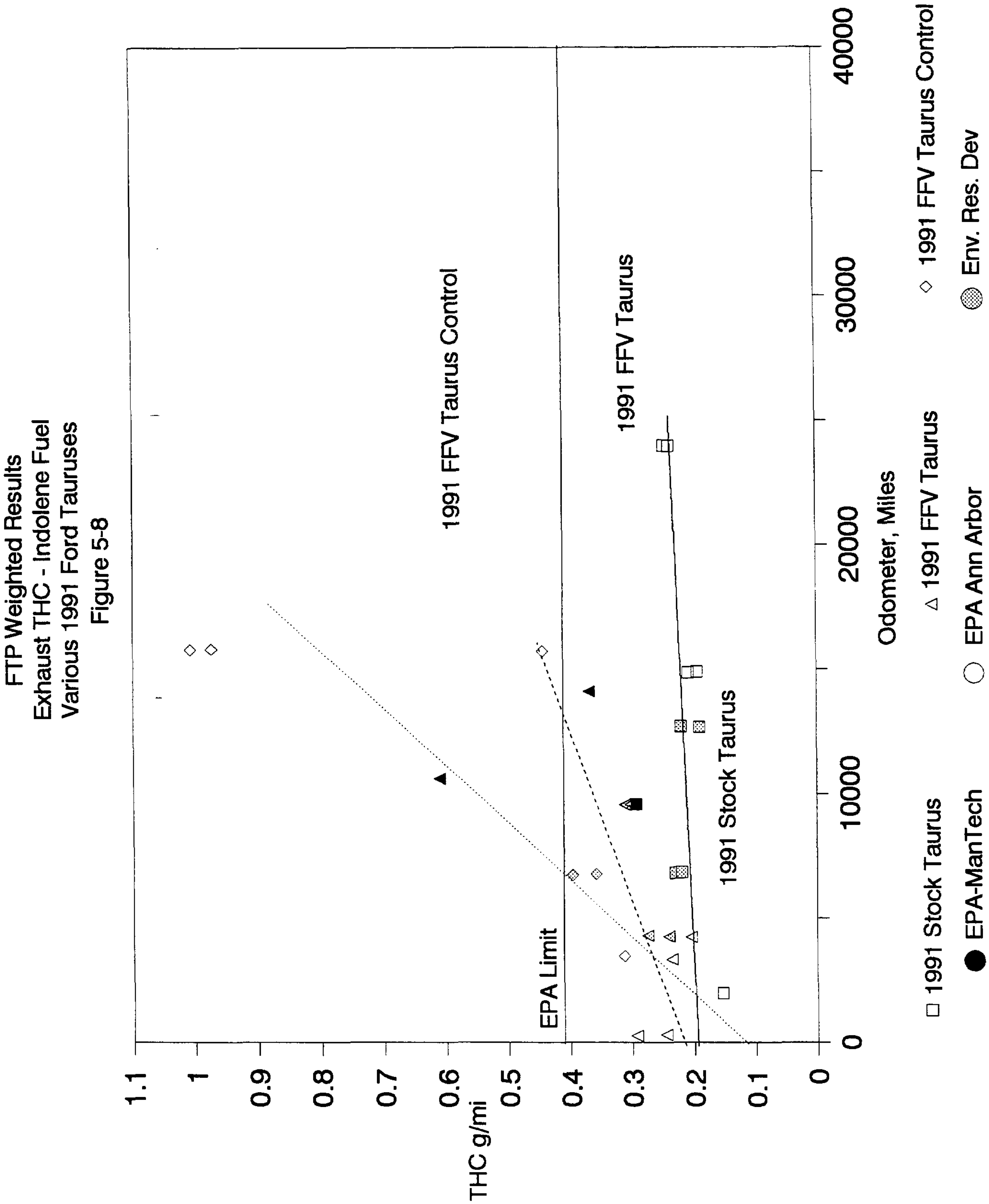


FTP Weighted Results
Exhaust NOx - M85 Fuel
Flexible Fueled 1991 Ford Tauruses & 1991 Chevrolet Luminas
Figure 5-6



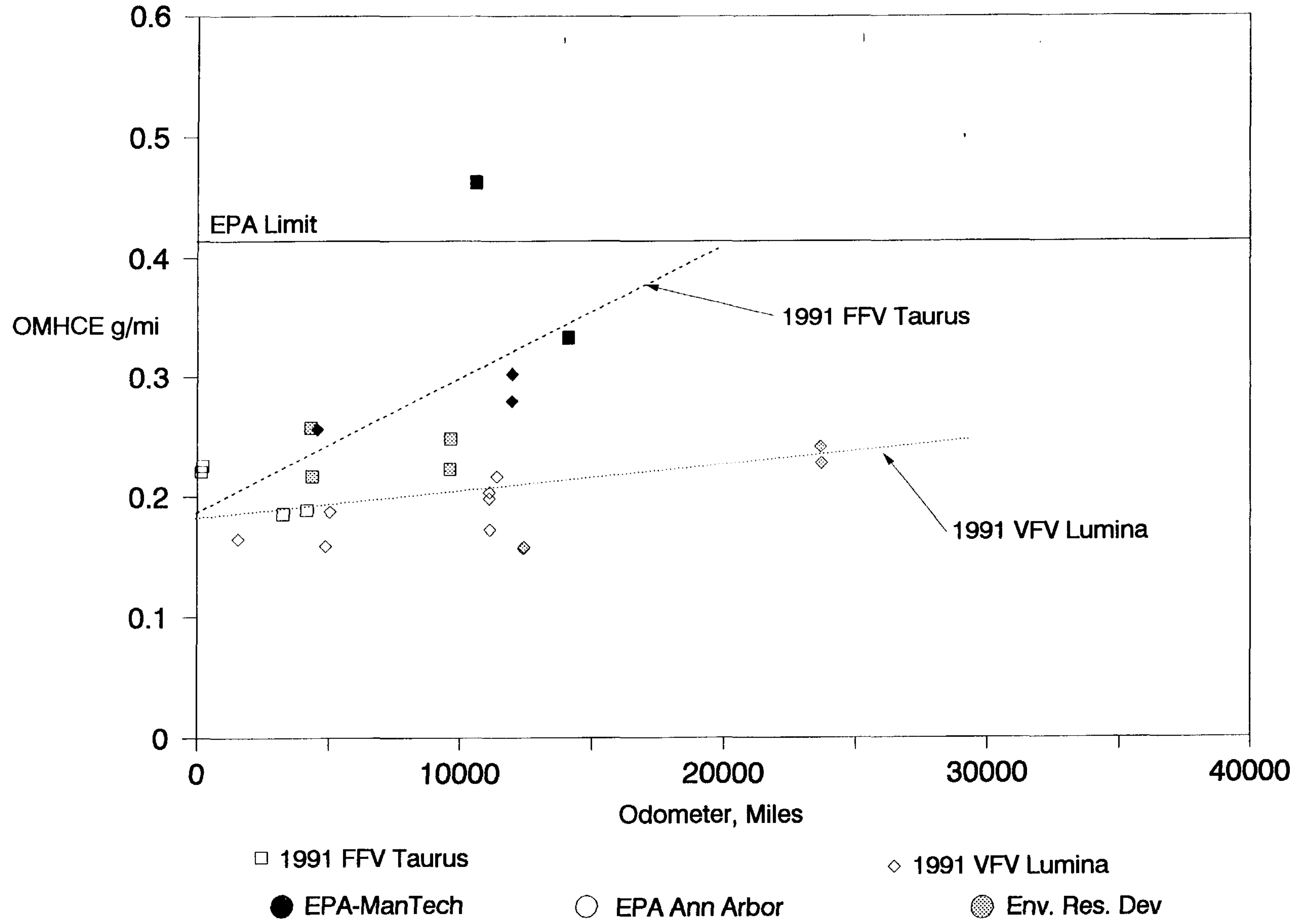
FTP Weighted Results
Exhaust THC - Indolene Fuel
Various 1991 Chevrolet Luminas
Figure 5-7



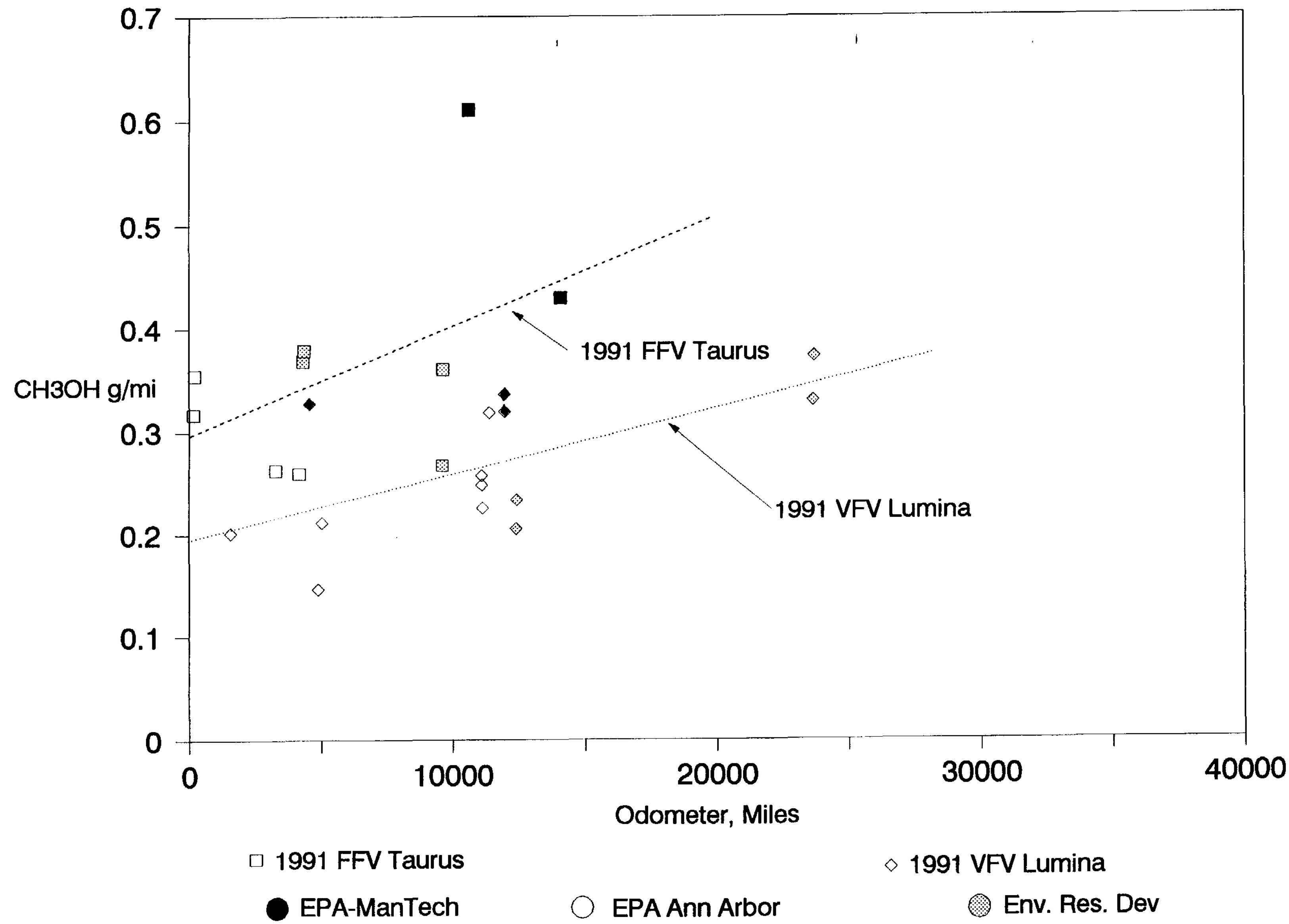


FTP Weighted Results
Exhaust THC - Indolene Fuel
Various 1991 Ford Tauruses
Figure 5-8
THC g/mi
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
10000
20000
30000
40000
Odometer, Miles
EPA Limit
1991 FFV Taurus Control
1991 FFV Taurus
1991 Stock Taurus
1991 Stock Taurus
1991 FFV Taurus
1991 FFV Taurus Control
EPA-ManTech
EPA Ann Arbor
Env. Res. Dev

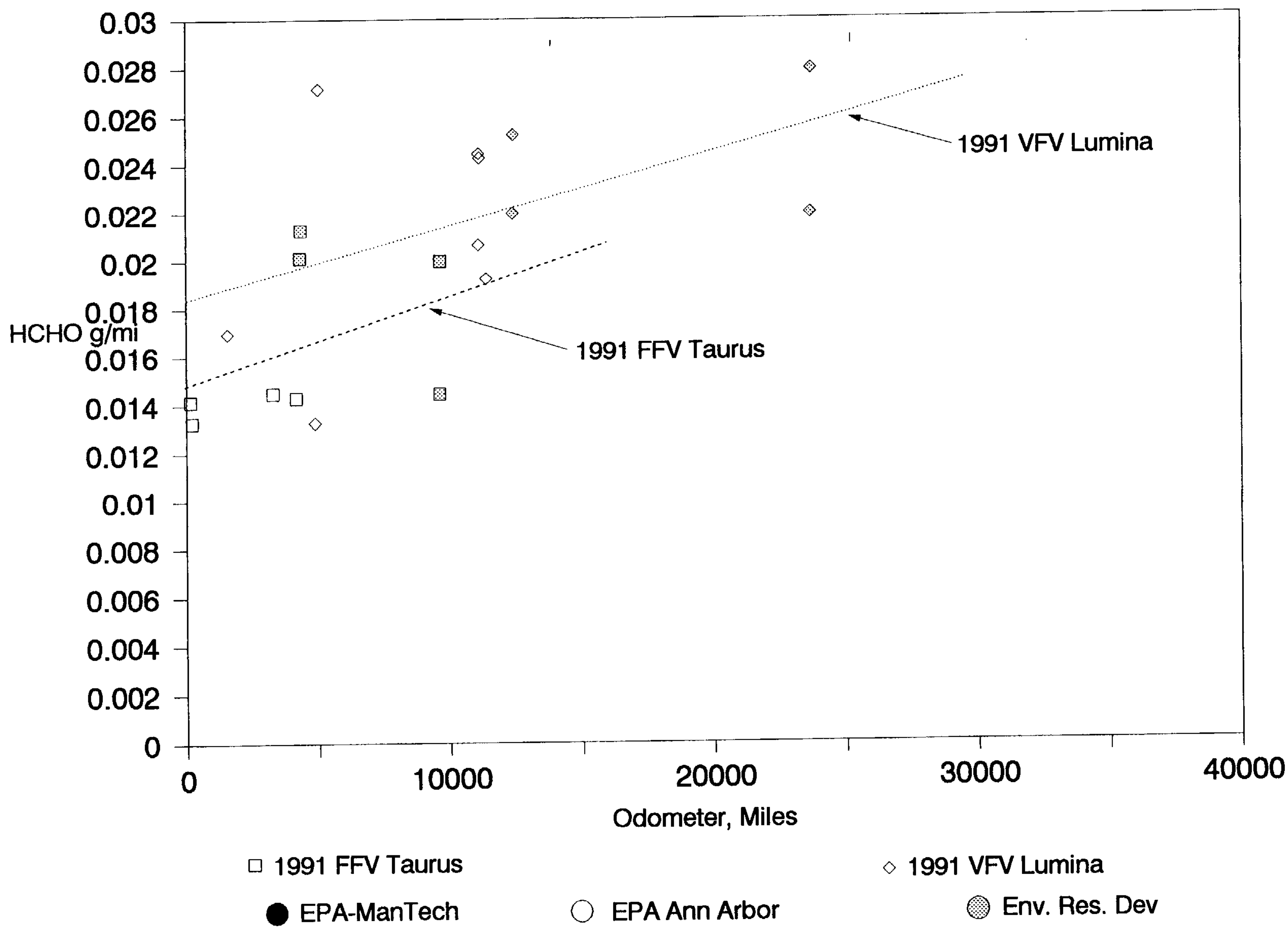
FTP Weighted Results
Exhaust OMHCE - M85 Fuel
Flexible Fueled 1991 Ford Tauruses & 1991 Chevrolet Luminas
Figure 5-9



FTP Weighted Results
Exhaust CH3OH - M85 Fuel
Flexible Fueled 1991 Ford Tauruses & 1991 Chevrolet Luminas
Figure 5-10

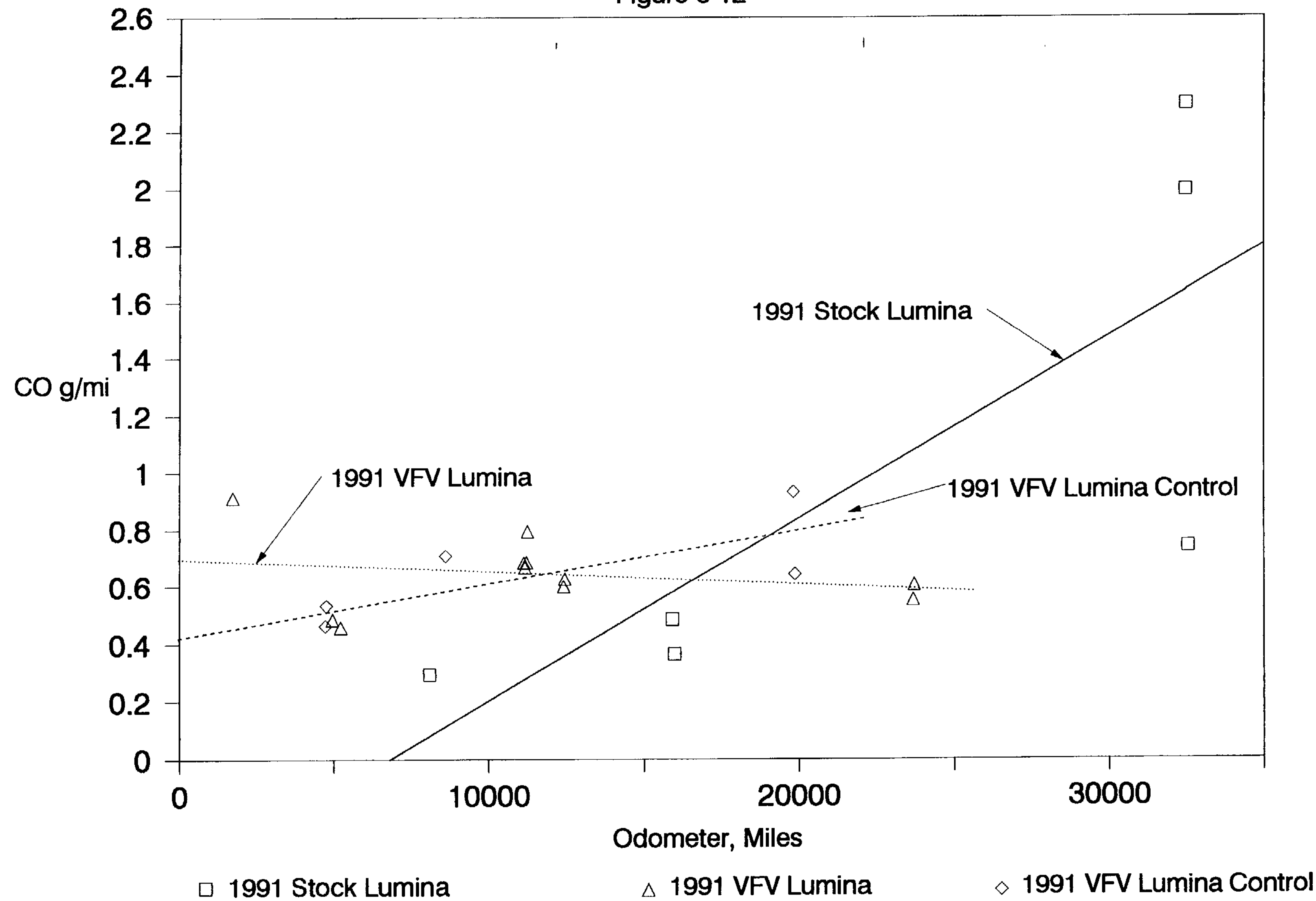


FTP Weighted Results
Exhaust HCHO - M85 Fuel
Flexible Fueled 1991 Ford Tauruses & 1991 Chevrolet Luminas
Figure 5-11

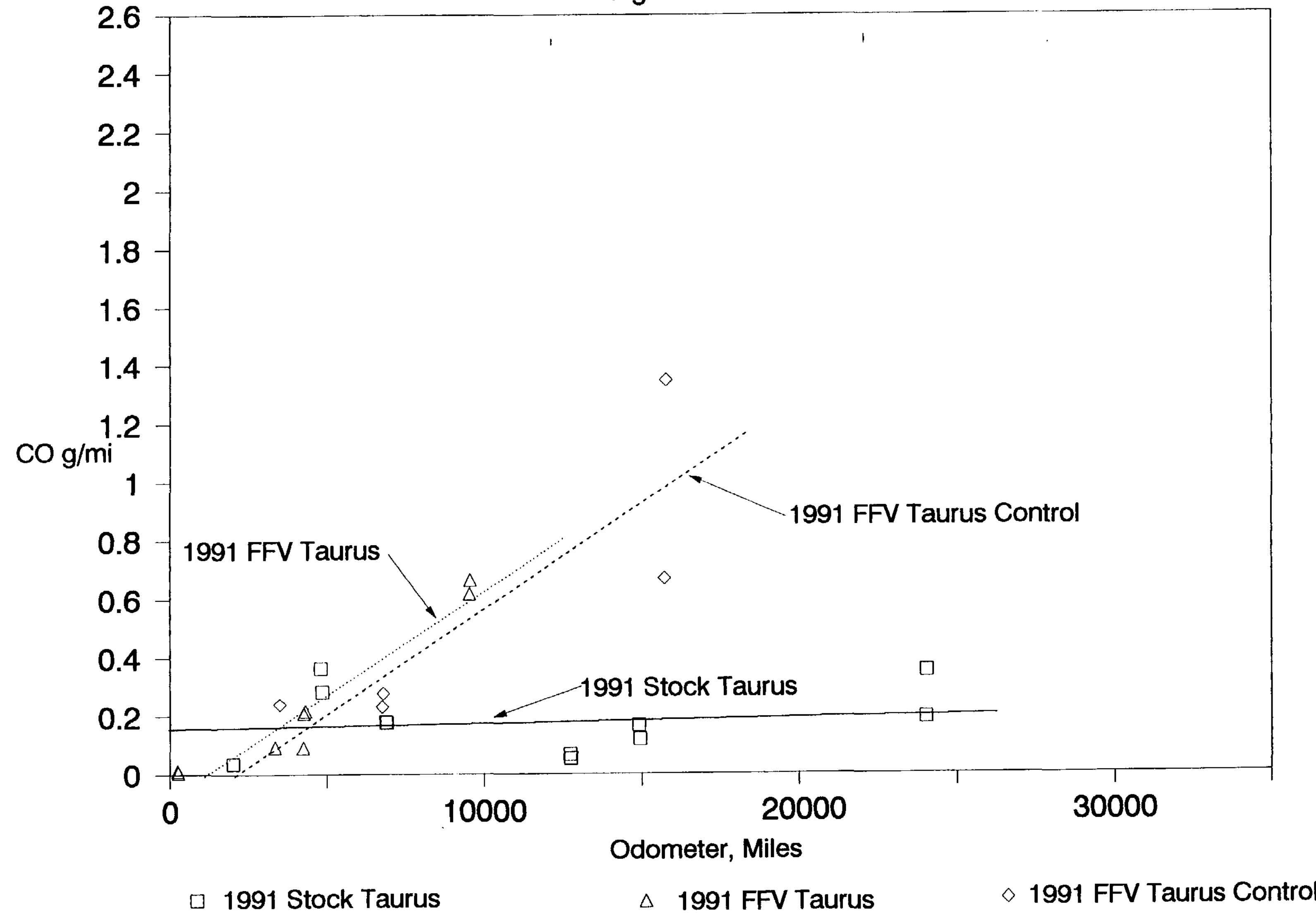


Highway Cycle Results
Exhaust CO - Indolene Fuel
Various 1991 Chevrolet Luminas

Figure 5-12

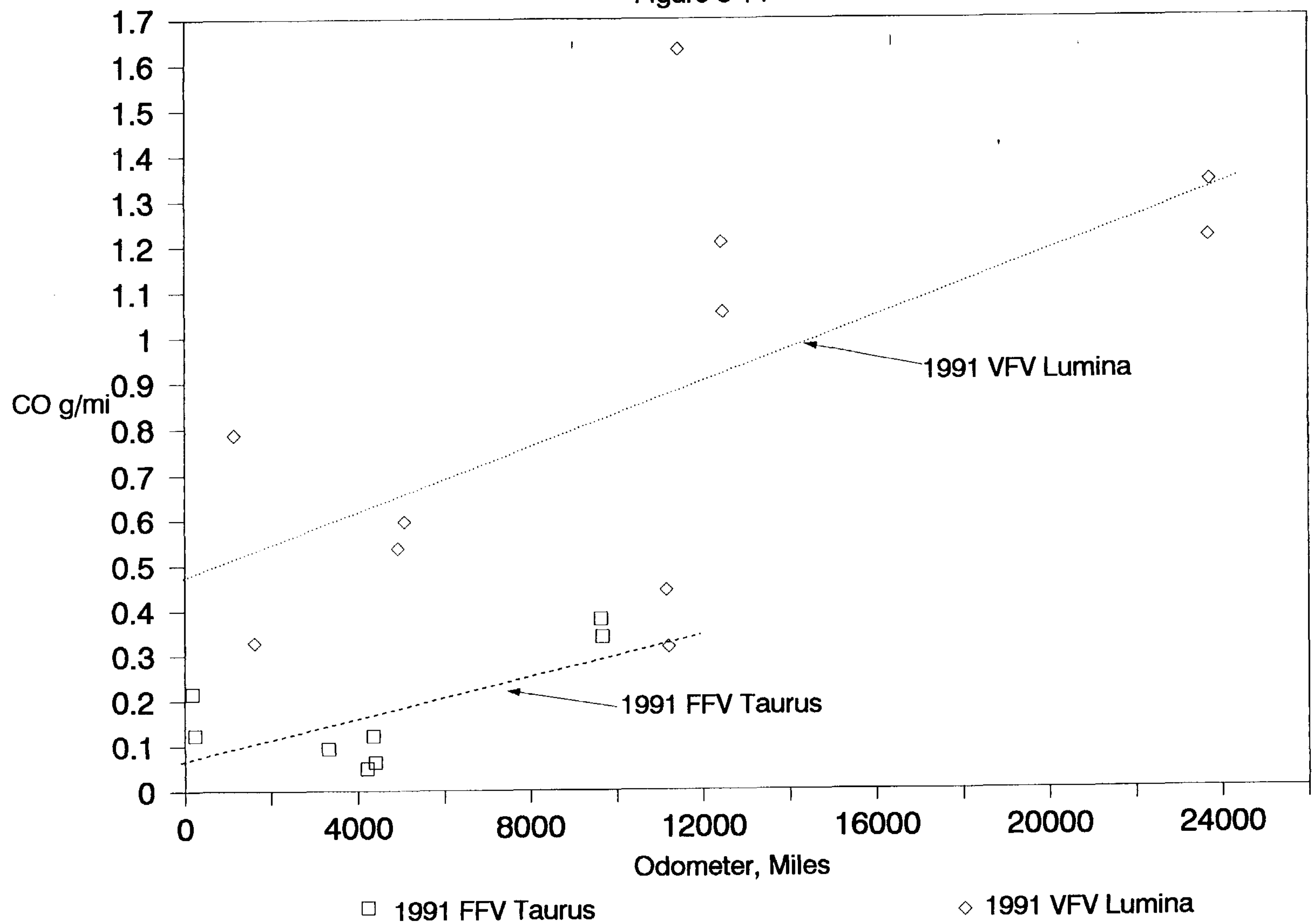


Highway Cycle Results
Exhaust CO - Indolene Fuel
Various 1991 Ford Tauruses
Figure 5-13



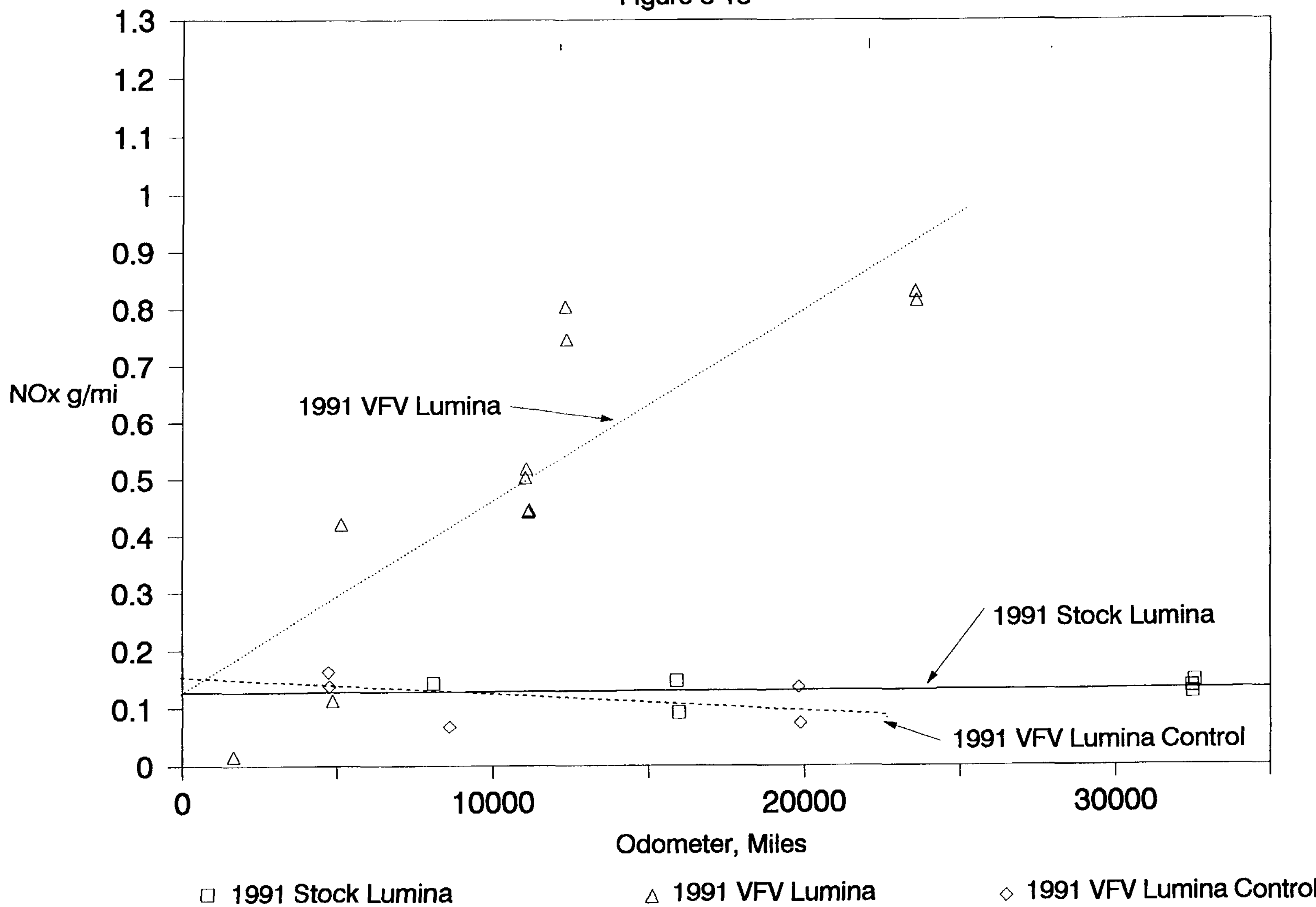
Highway Cycle Results
Exhaust CO - M85 Fuel
Various 1991 Chevrolet Luminas & Ford Tauruses

Figure 5-14



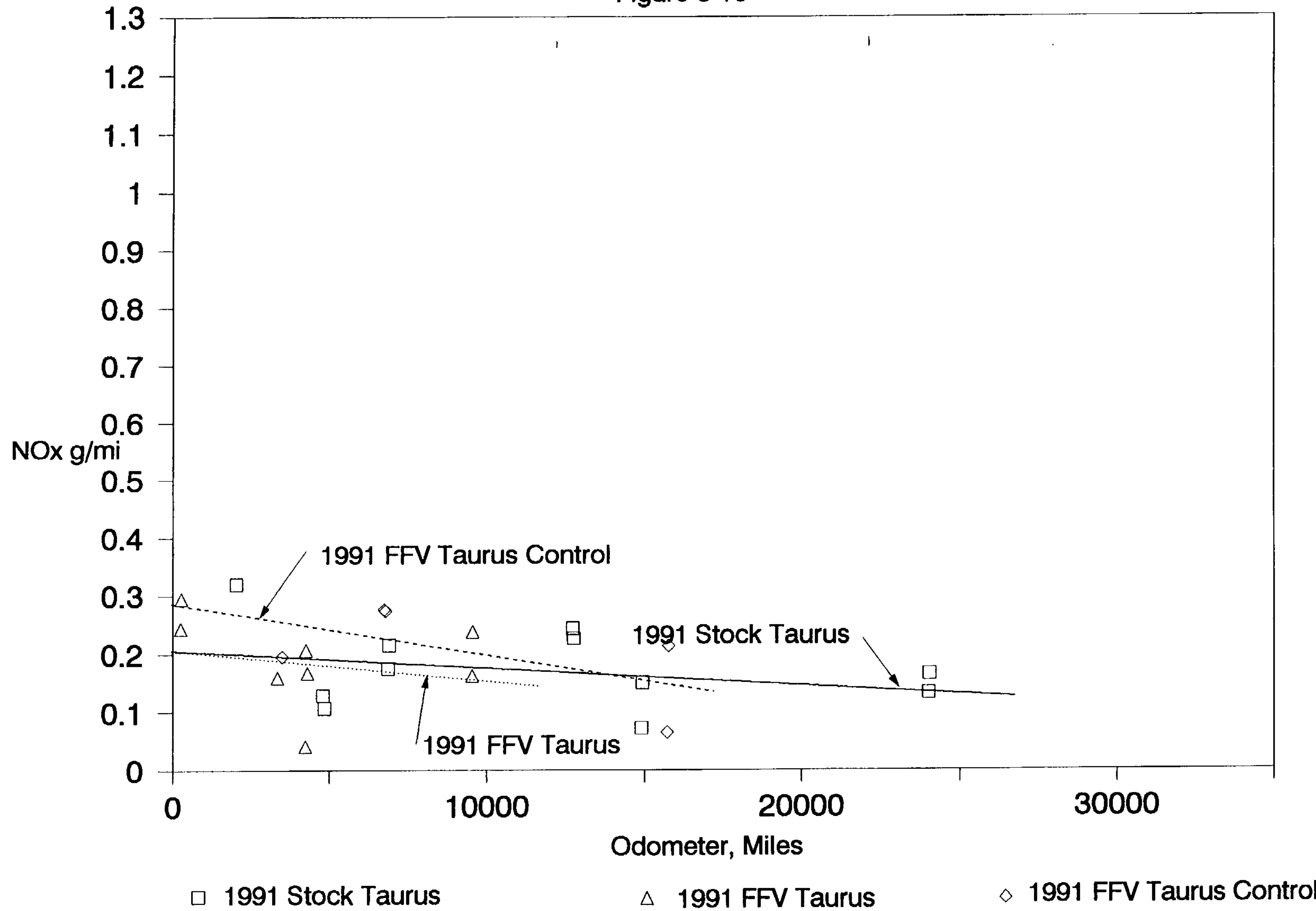
Highway Cycle Results
Exhaust NOx - Indolene Fuel
Various 1991 Chevrolet Luminas

Figure 5-15

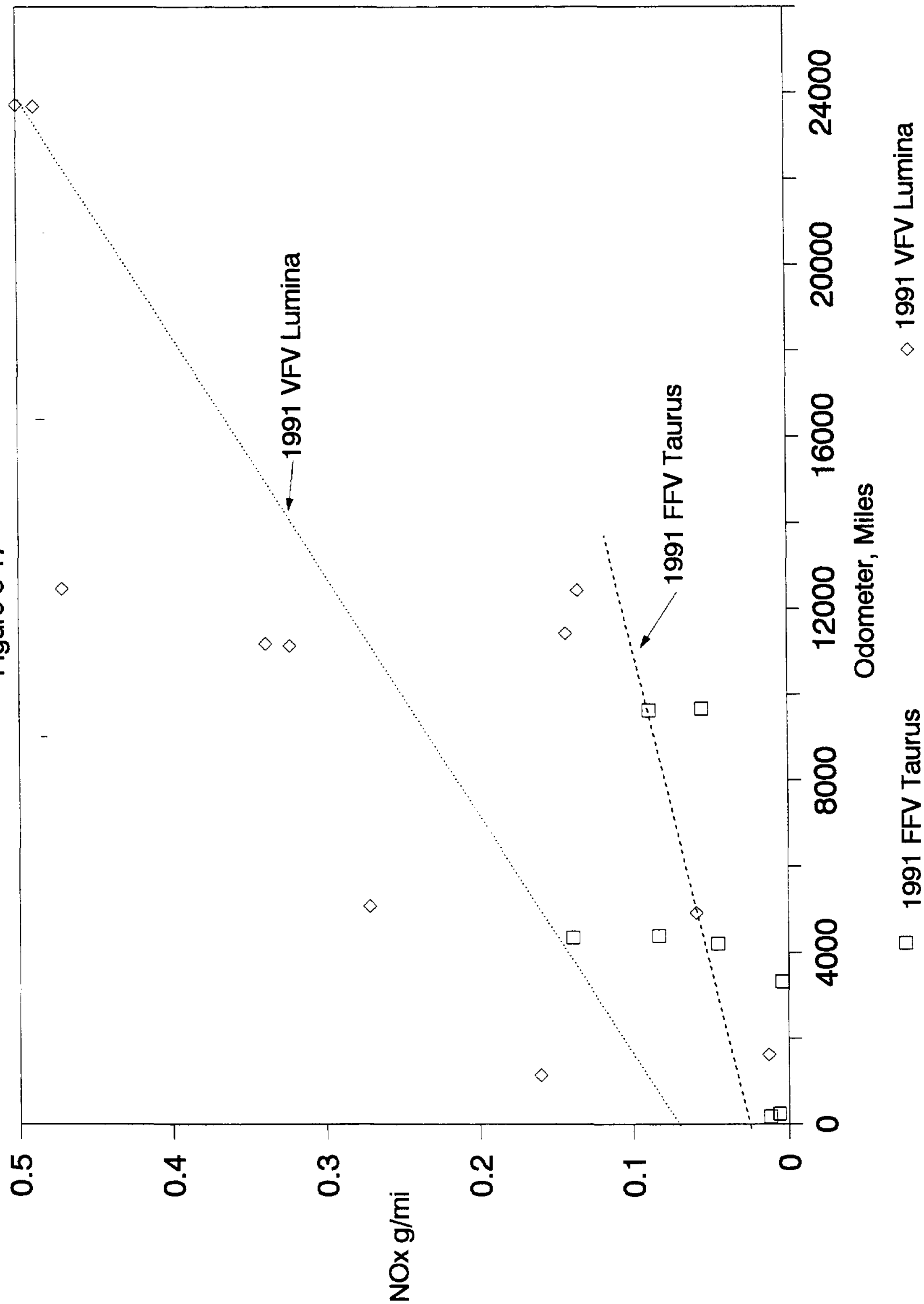


Highway Cycle Results
Exhaust NOx - Indolene Fuel
Various 1991 Ford Tauruses

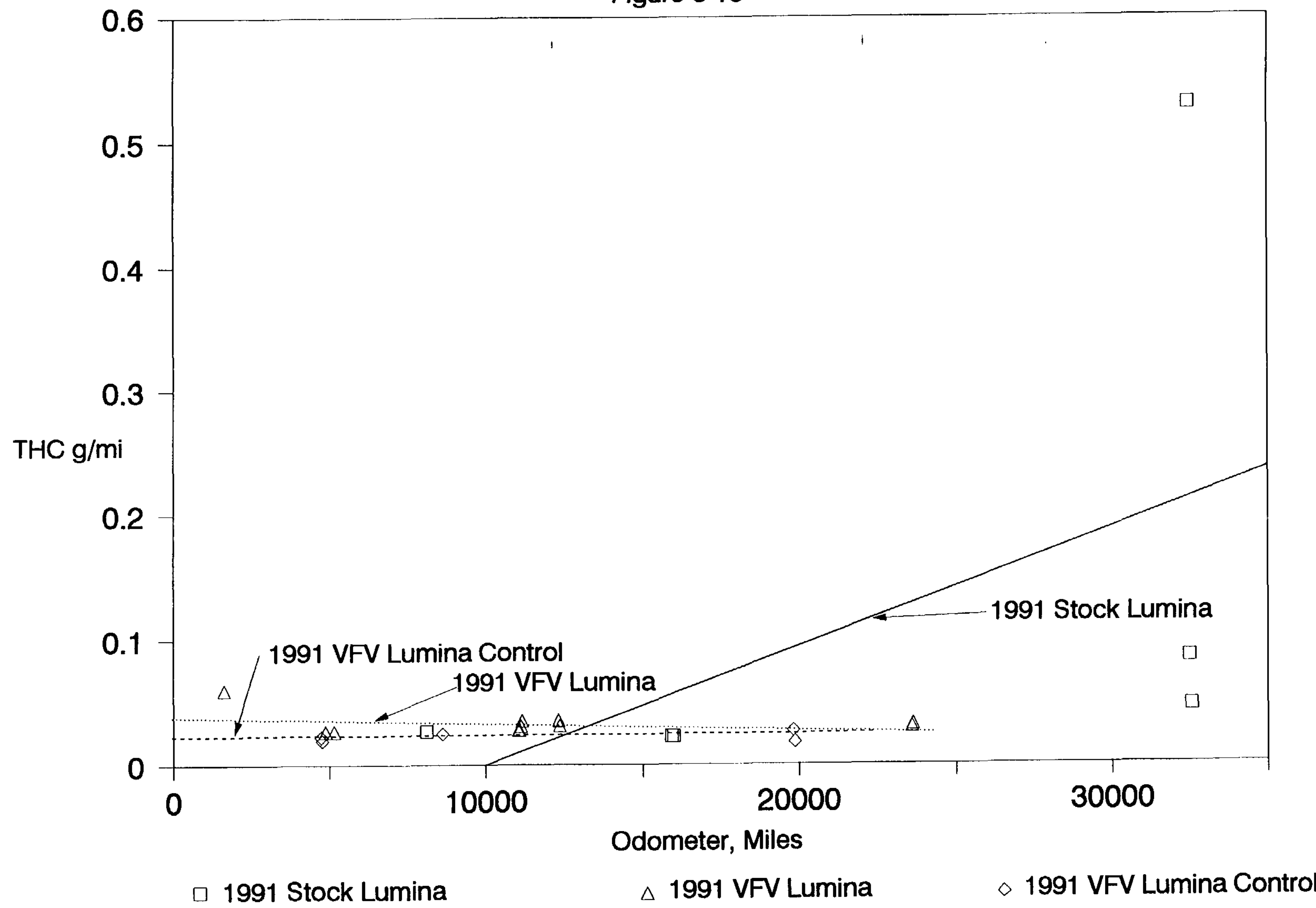
Figure 5-16



Highway Cycle Results
Exhaust NOx - M85 Fuel
Various 1991 Chevrolet Luminas & Ford Tauruses
Figure 5-17

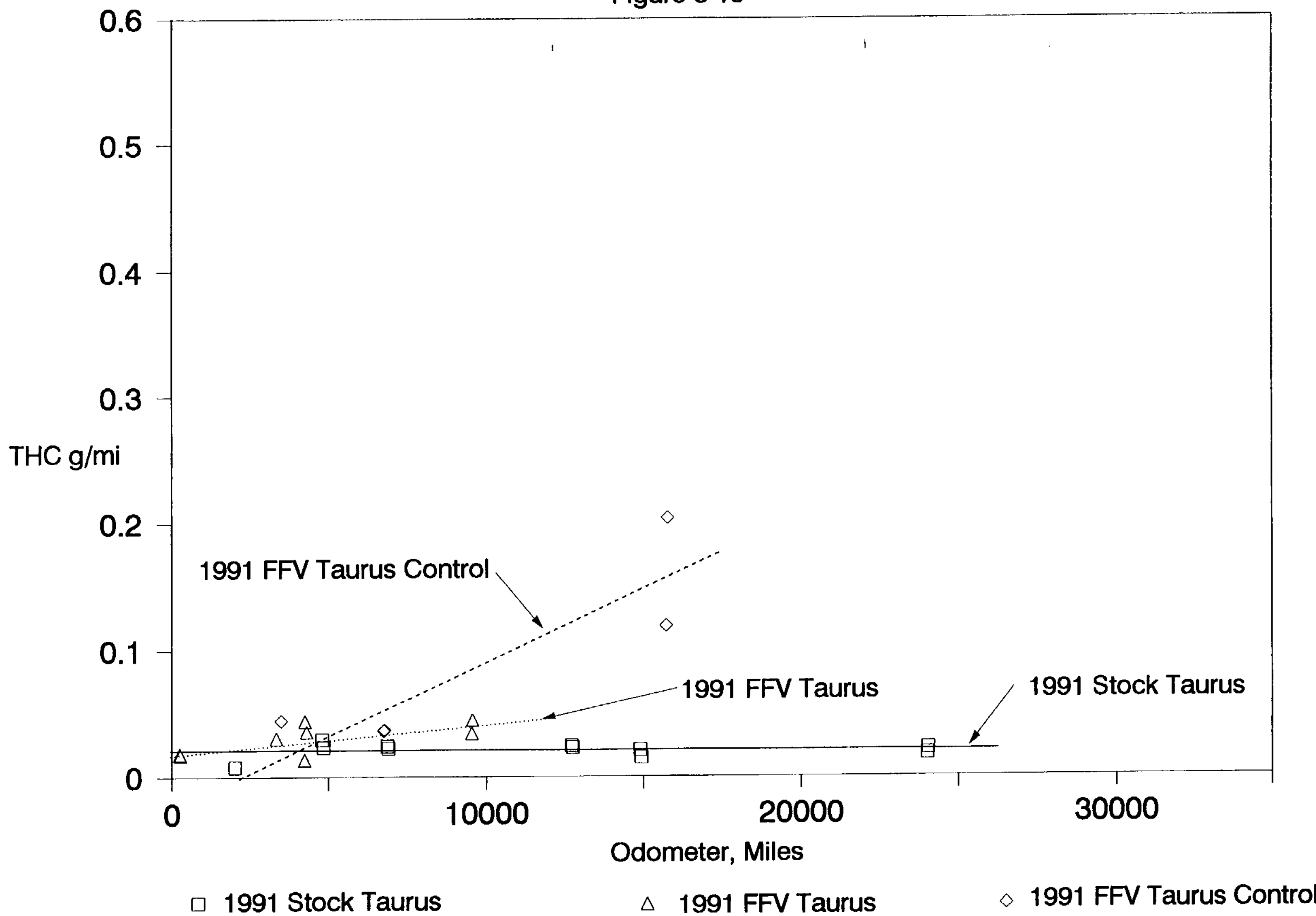


Highway Cycle Results
Exhaust THC - Indolene Fuel
Various 1991 Chevrolet Luminas
Figure 5-18



Highway Cycle Results
Exhaust THC - Indolene Fuel
Various 1991 Ford Tauruses

Figure 5-19



Highway Cycle Results
Exhaust OMHCE - M85 Fuel
Various 1991 Chevrolet Luminas & Ford Tauruses

Figure 5-20

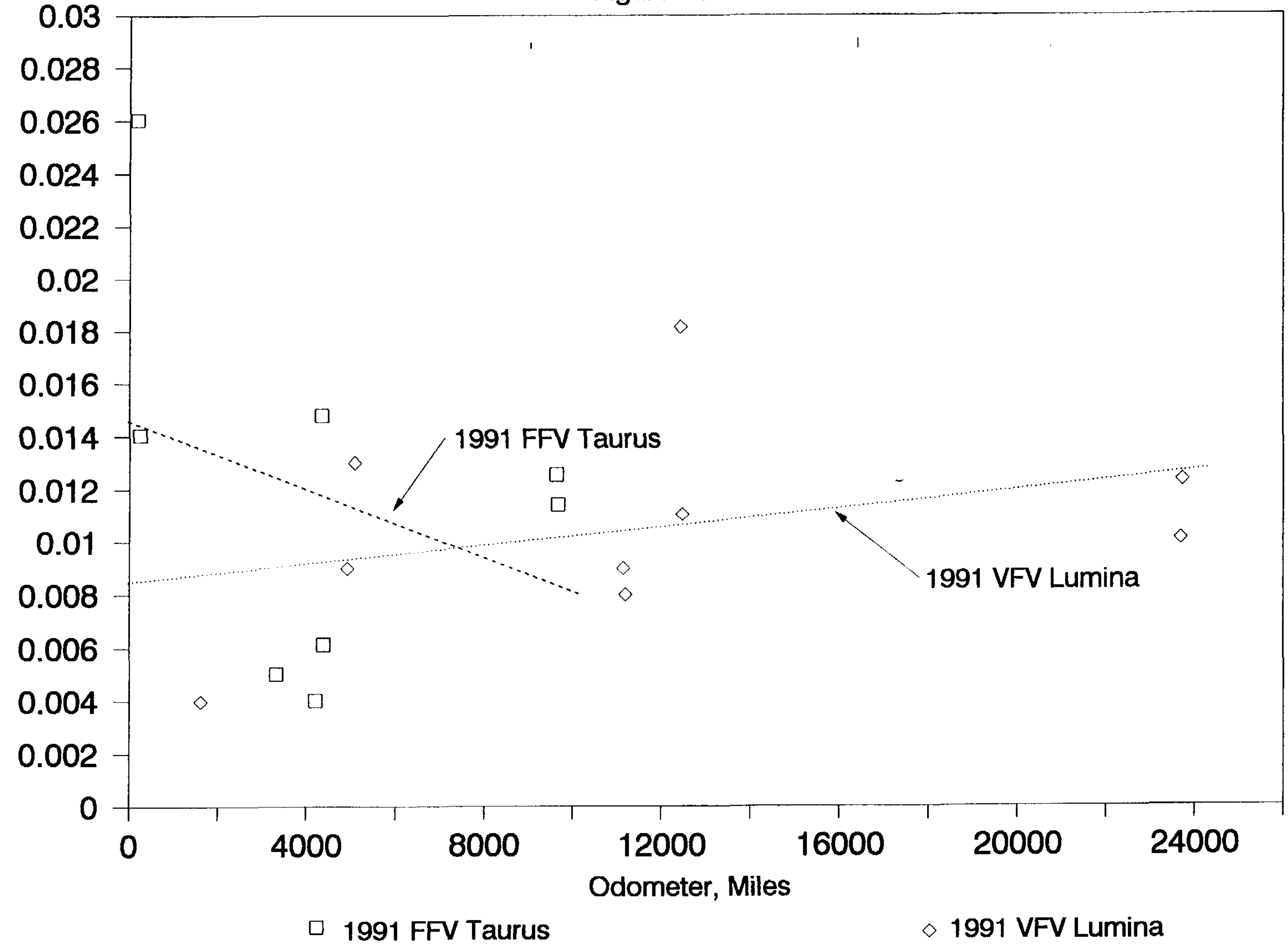


Table 5-1

Types of Emissions Tests Completed on AMFA I Vehicles by Fuel and Vehicle Type

Vehicle Type	Number of Vehicles Tested	Total Dynamometer Test	FTP Cycle			EPA Highway Cycle			Evaporative Tests		
			Indolene Fuel	M85 Fuel	Other Fuel	Indolene Fuel	M85 Fuel	Other Fuel	Indolene Fuel	M85 Fuel	Other Fuel
1991 VFV Lumina	5	52	13	14	25	7	4	2	12	13	18
1991 VFV Lumina Control	2	6	6			6			5		
1991 Stock Lumina	2	12	9		3	8	7	2	8		3
1991 FFV Taurus	5	38	10	10	18	7	8				
1991 FFV Taurus Control	2	6	6			5					
1991 Stock Taurus	2	13	10		3	9			1		3
Total	18	127	54	24	49	42	19	4	26	13	24

Table 5-2								
FTP and HWFET Dynamometer Test Results for El Paso CNG C-2500 Pickups								
Decal ID	Date	Vehicle Mileage	Test Type	THC g/mi	CH4 g/mi	NMHC g/mi	CO g/mi	NOx g/mi
EL015CC	3/30/93	5218	FTP	1.9	1.86	0.04	12.92	0.55
EL023CC	3/30/93	4328	FTP	1.51	1.5	0.02	10.84	0.22
EL019CC	5/5/93	4231	FTP	1.17	1.14	0.03	6.98	0.43
EL019CC	5/5/93	4242	HWFET	0.89	0.84	0.06	10.23	0.4

Section 6.0 Future Considerations

Resulting from this first analysis of the data in the AFDC, several items for future consideration and analysis have been identified.

6.1 Program Monitoring and Data Quality Assessment

Daily Mileage Information. Much of the analysis in the program monitoring and fuel analysis sections relied on vehicle daily mileage accumulation information. Without this information, the analysis would have been much more difficult. The accumulation of this information is seen to be fairly critical to the successful analysis of the data that continues to be gathered in the program.

Vehicle Route Characterization. Information on the duty cycle of the vehicles may be quite valuable in assessing the performance, fuel economy, and maintenance required for the vehicles in the program.

Unscheduled Maintenance. A more in-depth analysis should be performed that would compare and attempt to correlate the driver-reported unscheduled maintenance occurrences noted on the weekly log sheets with the dates of unscheduled maintenance as reported from the shop maintenance records.

Maintenance Tracking. More care needs to be taken in the field to assure that maintenance records (both scheduled and unscheduled) are being gathered as completely and quickly as possible. In most cases, there are more shop records on unscheduled maintenance than on driver-reported occurrences of unscheduled maintenance. It is troubling when there are more driver-reported unscheduled maintenance occurrences than those collected from the maintenance and repair shops.

Vehicle Refueling. To help ensure better data quality, the importance of refueling with the appropriate alternative fuel, and reporting that refueling at every occurrence, needs to be emphasized to the program personnel and drivers associated with the vehicles in the field.

Oil Changes. The subject of lube oil changes has not been addressed in this document, but taking alcohol vehicles to non-approved dealerships for scheduled maintenance (which would include an oil change), may have severe implications on the performance of the vehicle. Monitoring of scheduled maintenance and the proper care of the vehicles needs to continue to receive attention.

6.2 Fuel Economy Analysis

Fuel Economy - CNG. Although the CNG data on fuel economy present a fairly precise story, especially relative to methanol, there are no control OEM vehicles with which to compare the data. The next report should provide this analysis, when control OEM vehicles, which are identical to the CNG vehicles other than the fuel systems, many already in the field, begin reporting.

Fuel Economy - Data Quality and Assurance. One of the major problems in attempting to interpret fuel economy from the data gathered to date is to try to assess the accuracy and totality of the data received. A major effort is needed to incorporate the GasCard data and SunCard refueling data into the AFDC. This might help to fill voids present in the historical data, as well as to cross-check data as they are received from the drivers in the field on the current data.

6.3 Performance and Unscheduled Maintenance Analysis

Maintenance and Fuel Records from GSA. In order to complete the possible missing data on shop maintenance, both scheduled and unscheduled, it is suggested that the AFDC, DOE, and GSA investigate what it would take to make the GSA maintenance (and fuel) records available to the AFDC.

6.4 Emissions Analysis

Emissions Analysis Needs. More chassis dynamometer testing needs to be performed on CNG vehicles. The new emissions contracts about to be signed at NREL will include tests on about 400 vehicles in the next 12 months. This will include more CNG and ethanol vehicles.

Emissions Data Quality and Reliability. Because there were three different emissions laboratories involved in this first phase of testing and as many as six different laboratories in next years testing there are questions about the correlation of data between labs. We attempted to look for lab variations in the current set of data, but the only way to be sure of lab to lab consistency is to perform a lab correlation study. This involves taking one or two vehicles from lab to lab and perform the standard series of test at each lab to determine uniformity of testing and assure data quality and reliability. Both Ford and GM, and potentially Chrysler, have expressed a willingness to cooperate in such a study with their respective vehicles, at no cost to the program.

Section 7.0 References

Black, F., Gabele, P., "Emissions and Fuel Economy of Federal Alternatively Fueled Fleet Vehicles," Annual Automotive Technology Development Contractors' Coordination Meeting, Dearborn, Michigan, November, 1992.

Black, F., Kleindienst T., "Emissions and Fuel Economy of DOE Flex-Fuel Vehicles," Annual Automotive Development Contractors' Coordination Meeting, Dearborn, Michigan, October, 1991.

8.0 Acknowledgments

We would like to thank several other people, without whose efforts this report would have been impossible. Dee Ringleman, Loren Bendykowski, Karen Piper and Myron China have designed, populated and assured the quality and integrity of the database on a daily basis. Karen Pipēr also assisted in the timely typing and proofing of this final report. Without sufficient lead time René Texeria did a tremendous edit on these engineers' scribblings.

Appendix

General
Section 1

Table 5.1-1 Vehicle Descriptions Covered in this Report						
	Taurus FFV	Standard Taurus	Lumina VFV	Standard Lumina	Dodge RAM Van	Chevrolet Pick-up
MAKE	FORD	FORD	GMC-CHEVY	GMC-CHEVY	CHRYS-DODGE	GMC-CHEV
MODEL	TAURUS	TAURUS	LUMINA	LUMINA	RAM_250	C2500
Body Style	4 Door Sedan	4 Door Sedan	4 Door Sedan	4 Door Sedan	B Series Van/Fltside	Pickup
Model Year	1991	1991	1991	1991	1992	1992
AIR_COND			Y	Y	Y	Y
Design Fuel	M85	GASOLINE	M85	GASOLINE	CNG	CNG
Fuel System	FLEXIBLE	DEDICATED	FLEXIBLE	DEDICATED	DEDICATED	DEDICATED
Fuel Tank, gal	20.5	20.5	16.5	16.5	11	
Veh. Weight, lb			4401	4401	6400	7200
Load Cap. lb			1948	1948	3300	2285
Tow Cap. lb			1000	1000	2000	3800
Front Tire Size			P195/75R14	P195/75R14	P235/75R15	LT245/75R16
Rear Tire Size			P195/75R14	P195/75R14	P235/75R15	LT245/75R16
Num. Axles	2	2	2	2	2	2
Num Tires	4	4	4	4	4	4
Engin Model			LHO	LHO		NP25.785CAEA
Eng. Manuf.			GM	GM	CHRYSLER	GM
Eng. Displac., l	3	3	3.1	3.1	5.2	5.7
Eng. Config	V-6	V-6	V-6	V-6	V-8	V-8
Fuel Delivery	EFI	EFI	FI	FI	MP	TB
Aspiration?	- N	N	N	N	N	N
Eng. HP			140	140	200	210
Comp. Ratio			8.8:1	8.8:1	8.9:1	8.3:1
Oil Cap. Qts.			4.6	4.6	5	5
Cam Shaft			PUSHROD	PUSHROD	PUSHROD	PUSHROD
Valves/Cyl			2	2	2	2
Num Cylinders			6	6	8	8
Trans. Type	A	A	AO	AO	A	A
Trans. Lockup			Y	Y	N	Y
Num Gears			4	4	3 or 4	4
Gear 1 Ratio			2.92:1	2.92:1	2.74:1	3.06:1
Gear 2 Ratio			1.56:1	1.56:1	1.54:1	1.63:1
Gear 3 Ratio			1:1	1:1	1:1	1:1
Gear 4 Ratio			.7:1	.7:1		.7:1
Axle Ratio			3.33:1	3.33:1	3.55:1	3.42:1
Drive Wheels	FWD	FWD	FWD	FWD	RWD	RWD

Appendix

Program Monitoring
Section 2

Table A.2-1

Selected Information for Miles, Reporting, and Service for Argonne

Decal ID	Total Miles	Miles Reported	% Reported	Months in Service	Miles/Veh/Month
AR001EL	5092	5092	100	6.5	783.4
AR002EL	3847	3847	100	6.3	610.6
AR003EL	5408	5408	100	7.5	721.1
AR004EL	3212	3212	100	6.5	494.2
AR005CR	1090	1090	100	6	181.7
AR006CR	2102	2102	100	5.8	362.4
AR007CR	1528	1528	100	9	169.8
AR008CR	2607	2607	100	5.8	449.5
AR009CR	2188	2188	100	5.6	390.7
AR010CS	1288	1288	100	5.3	243.0
AR011CS	2280	2280	100	6.5	350.8
AR012CS	1550	1550	100	6.4	242.2
AR013CS	1247	1247	100	6.3	197.9
AR014EL	3829	3829	100	6	638.2

Table A.2-2

Selected Information for Miles, Reporting, and Service for Bakersfield

Decal ID	Total Miles	Miles Reported	% Reported	Months in Service	Miles/Veh/Month
BK001CR	13028	13028	100	11.4	1142.8
BK002CR	14145	14145	100	11.5	1230.0
BK003CR	17026	16829	98.8	11.4	1493.5
BK004CR	17991	17991	100	11.4	1578.2
BK005CR	11853	10744	90.6	10.8	1097.5
BK006CR	9410	9410	100	11.1	847.7
BK007CR	17144	17045	99.4	11.4	1503.9
BK008CR	11577	11577	100	11.5	1006.7
BK009CR	9581	9581	100	11.2	855.4
BK010CR	10538	10538	100	11.1	949.4
BK011CR	15659	15659	100	10.5	1491.3
BK012CR	16781	16781	100	11.4	1472.0
BK013CR	18434	18382	99.7	11.4	1617.0
BK014CR	11537	10430	90.4	11.4	1012.0
BK015CR	10995	10995	100	11.1	990.5
BK016CR	11901	11901	100	11.3	1053.2
BK017CR	11195	11195	100	11.6	965.1
BK018CR	11175	10932	97.8	11.5	971.7
BK019CR	10344	10344	100	11.1	931.9
BK020CR	9105	9105	100	4.9	1858.2

Table A.2-3

Selected Information for Miles, Reporting, and Service for El Paso, TX

Decal ID	Total Miles	Miles Reported	% Reported	Months in Service	Miles/Veh/Month
EL001CS	1294	1294	100	2.9	446.2
EL002CS	1001	1001	100	5.2	192.5
EL003CS	458	458	100	5.2	88.1
EL004CS	2283	2171	95.1	5.2	439.0
EL005CS	1220	958	78.5	5	244.0
EL006CS	1230	1119	91	5.2	236.5
EL007CS	1724	1724	100	5.2	331.5
EL008CS	2291	2291	100	5.2	440.6
EL009CS	2585	2585	100	4.6	562.0
EL010CS	2058	2058	100	4.5	457.3
EL011CS	3382	3105	91.8	5.2	650.4
EL012CS	2873	2357	82	5.2	552.5
EL013CS	1485	1328	89.4	5.2	285.6
EL014CS	779	779	100	5.2	149.8
EL015CS	4701	4701	100	5.2	904.0
EL016CS	1022	819	80.1	5.3	192.8
EL017CS	1086	968	89.1	5.2	208.8
EL018CS	1690	1251	74	5.2	325.0
EL019CS	3322	3107	93.5	5.2	638.8
EL020CS	1950	1950	100	5.1	382.4
EL021CS	2393	2326	97.2	5.2	460.2
EL022CS	1308	1308	100	2.2	594.5
EL023CS	3876	3876	100	5.2	745.4
EL024CS	799	799	100	2.5	319.6
EL025CS	1257	1257	100	5.2	241.7
EL026CS	1679	1679	100	3.3	508.8
EL027CS	1462	1388	94.9	5	292.4
EL028CS	2029	2029	100	5.2	390.2
EL029CS	3392	3392	100	5.2	652.3
EL030CS	1501	1303	86.8	5.2	288.7
EL031CS	2646	2540	96	4.4	601.4
EL032CS	1356	1263	93.1	5	271.2
EL033CS	4661	4429	95	5.3	879.4
EL034CS	3184	3050	95.8	5.2	612.3
EL035CS	2812	2812	100	4.2	669.5
EL036CS	727	727	100	4.9	148.4
EL037CS	1630	1355	83.1	5.2	313.5
EL038CS	3673	3544	96.5	5.3	693.0
EL039CS	2464	2464	100	3.8	648.4
EL040CS	2133	2133	100	5.2	410.2
EL041CS	6024	5664	94	5.3	1136.6
EL042CS	2531	2479	98	5.3	477.5
EL043CS	2813	2813	100	5.1	551.6
EL044CS	2413	2066	85.6	4.5	536.2
EL045CS	1591	1422	89.4	5.2	306.0
EL046CS	1519	1238	81.5	5.2	292.1
EL047CS	1779	1611	90.6	5.2	342.1
EL048CS	2460	2148	87.3	5.2	473.1

Table A.2-4

Selected Information for Miles, Reporting, and Service for Detroit, MI

Decal ID	Total Miles	Miles Reported	% Reported	Months in Service	Miles/Veh/Month
DT001ML	17085	16879	98.8	29.7	575.3
DT002ML	17121	16976	99.2	29.7	576.5
DT003ML	12367	12367	100	17.1	723.2
DT004ML	11926	11262	94.4	28.5	418.5
DT005MLC	28404	27372	96.4	30.6	928.2
DT006MT	10437	9850	94.4	28.5	366.2
DT007MT	11122	10221	91.9	28.5	390.2
DT008MT	34476	33864	98.2	28.1	1226.9
DT009MT	30330	29560	97.5	28.5	1064.2
DT010MT	30024	24329	81	28.3	1060.9
DT011MT	11395	9680	85	18.8	606.1
DT012MT	14250	13539	95	19.7	723.4
DT013MT	26665	25284	94.8	28.5	935.6
DT014MT	14357	14357	100	28.5	503.8
DT015MT	35698	35387	99.1	28.5	1252.6
DT016MT	31479	30198	95.9	27.6	1140.5
DT017MT	27012	25630	94.9	28.5	947.8
DT018MT	22561	21379	94.8	28.3	797.2
DT019MT	12451	4649	37.3	28.4	438.4
DT020MTC	29842	27276	91.4	28.2	1058.2
DT021GLC	10370	9284	89.5	26.2	395.8
DT022GLC	36904	34603	93.8	25.3	1458.7
DT023GTC	20859	17849	85.6	17.3	1205.7
DT024GTC	37923	33834	89.2	25.1	1510.9

Table A.2-5

Selected Information for Miles, Reporting, and Service for Los Angeles, CA

Decal ID	Total Miles	Miles Reported	% Reported	Months in Service	Miles/Veh/Month
LA001ML	33900	29564	87.2	27.1	1250.9
LA002ML	22424	21670	96.6	29.3	765.3
LA003ML	27792	27792	100	28.8	965.0
LA004ML	23591	22120	93.8	28.2	836.6
LA005ML	9285	9285	100	29	320.2
LA006MLC	10980	10980	100	29.8	368.5
LA007MT	28887	28119	97.3	28.7	1006.5
LA008MT	17122	16996	99.3	28.9	592.5
LA009MT	29687	28067	94.5	27.4	1083.5
LA010MT	56426	53716	95.2	29	1945.7
LA011MTC	22983	22831	99.3	28.6	803.6
LA012GTC	20855	20632	98.9	27.9	747.5
LA013GTC	21114	19022	90.1	24.9	848.0
LA014GLC	39648	34377	86.7	26.4	1501.8
LA015GLC	38856	30335	78.1	27	1439.1

Table A.2-6

Selected Information for Miles, Reporting, and Service for San Diego, CA,

Decal ID	Total Miles	Miles Reported	% Reported	Months in Service	Miles/Veh/Month
SD001ML	25089	24972	99.5	27.9	899.2
SD002ML	21878	21802	99.7	29.5	741.6
SD003ML	28628	21745	76	28.9	990.6
SD004ML	30034	29461	98.1	26.8	1120.7
SD005ML	49621	49052	98.9	29.5	1682.1
SD006MLC	30914	30500	98.7	29.5	1047.9
SD007MT	27365	27025	98.8	28.5	960.2
SD008MT	28425	28425	100	27.5	1033.6
SD009MT	16608	16407	98.8	28.3	586.9
SD010MT	31678	30705	96.9	27.2	1164.6
SD011MTC	22294	21218	95.2	27	825.7
SD012GTC	45488	38277	84.2	27.9	1630.4
SD013GTC	16297	16205	99.4	23	708.6
SD014GLC	16180	15344	94.8	27.5	588.4
SD015GLC	17221	17138	99.5	27.2	633.1

Table A.2-7

Selected Information for Miles, Reporting, and Service for Washington, DC

Decal ID	Total Miles	Miles Reported	% Reported	Months In Service	Miles/Veh/Month
DC001ML	8671	3078	35.5	22.9	378.6
DC002ML	11373	8363	73.5	29.7	382.9
DC003ML	24283	22575	93	27.9	870.4
DC004ML	11707	11387	97.3	29.3	399.6
DC005ML	21918	15535	70.9	28.6	766.4
DC006ML	14642	10655	72.8	30.1	486.4
DC007ML	25196	21346	84.7	26.7	943.7
DC008MLC	8700	8615	99	28.6	304.2
DC009MT	6719	5750	85.6	28.4	236.6
DC010MT	5656	5656	100	17	332.7
DC011MT	12306	10636	86.4	27.9	441.1
DC012MT	6990	6679	95.6	22.6	309.3
DC013MT	6768	4335	64.1	17.1	395.8
DC014MT	13809	6648	48.1	16.7	826.9
DC015MT	13538	7583	56	29.1	465.2
DC016MT	19224	15741	81.9	28.2	681.7
DC017MT	5692	4689	82.4	27.8	204.7
DC018MT	15169	13650	90	27.7	547.6
DC019MT	10297	6073	59	23.8	432.6
DC020MT	11671	11242	96.3	28.9	403.8
DC021MT	249	107	43	1.9	131.1
DC022MT	8459	6204	73.3	21.8	388.0
DC023MTC	11353	8277	72.9	23.2	489.4
DC024GTC	6625	3980	60.1	7.7	860.4
DC025GTC	7796	6151	78.9	10.6	735.5
DC026GLC	24780	23338	94.2	22.4	1106.3
DC027GLC	2908	1473	50.7	2.7	1077.0

Figure A.2-1

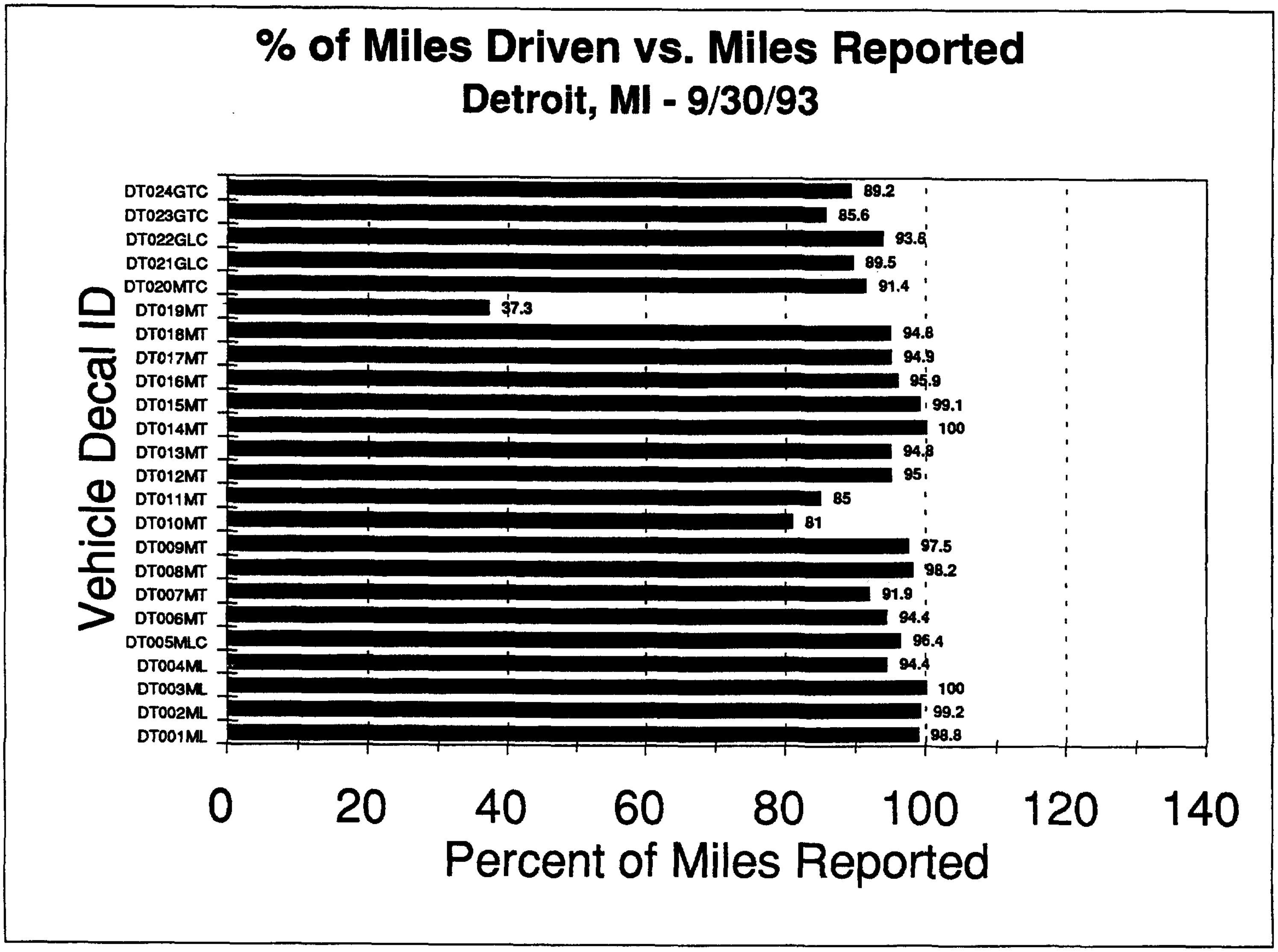
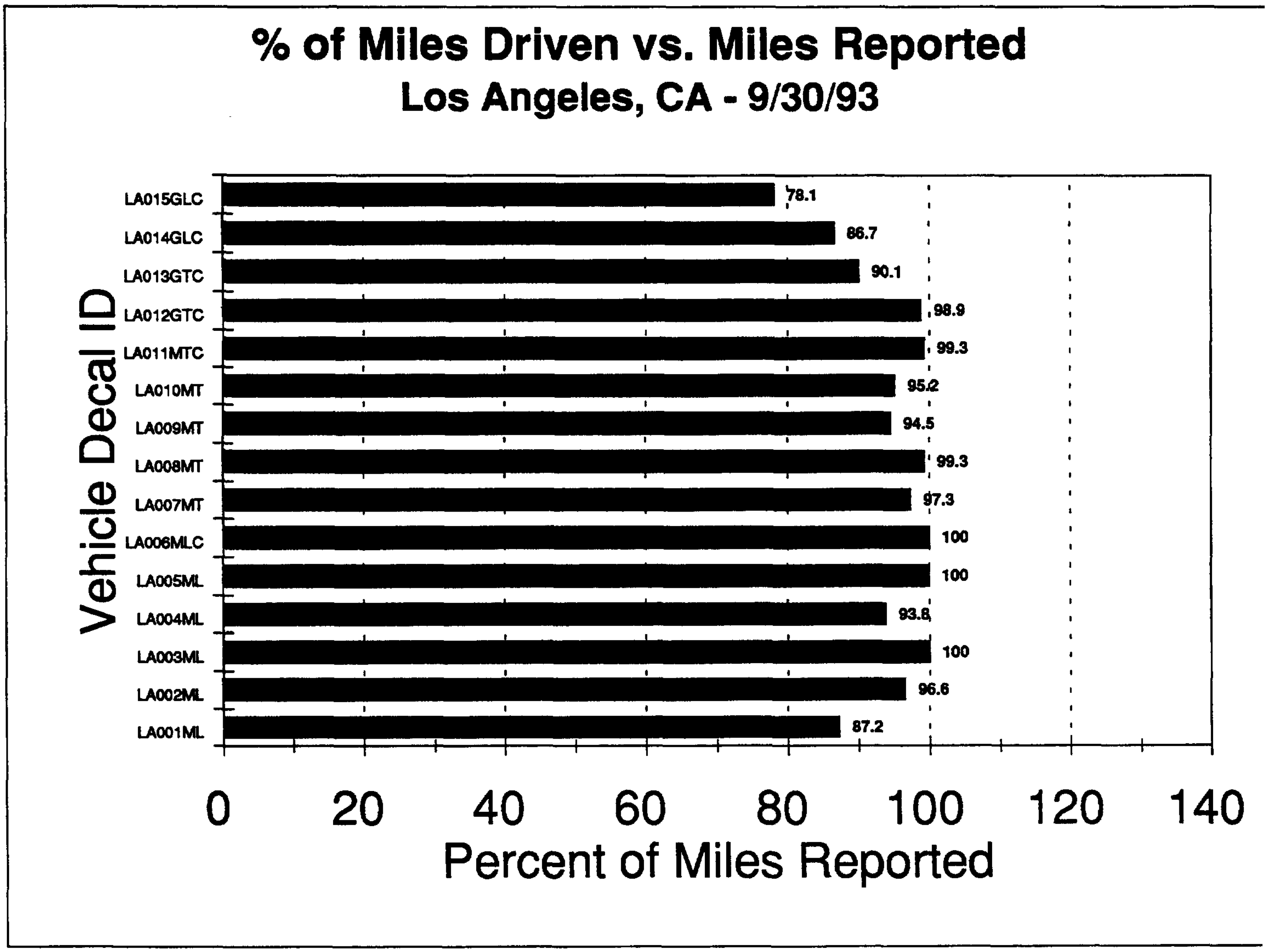
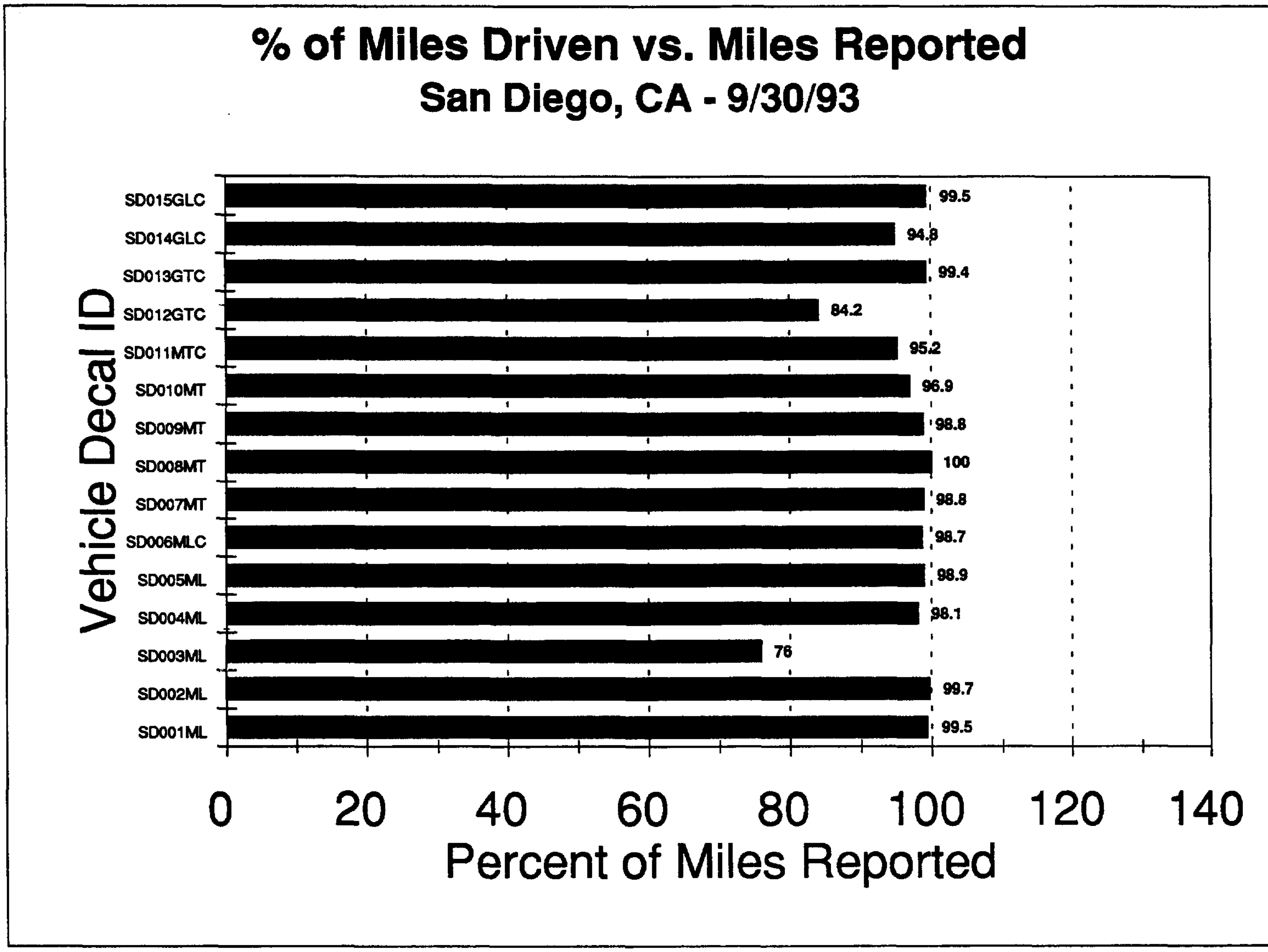

% of Miles Driven vs. Miles Reported
Detroit, MI - 9/30/93
Vehicle Decal ID
DT024GTC
DT023GTC
DT022GLC
DT021GLC
DT020MTC
DT019MT
DT018MT
DT017MT
DT016MT
DT015MT
DT014MT
DT013MT
DT012MT
DT011MT
DT010MT
DT009MT
DT008MT
DT007MT
DT006MT
DT005MLC
DT004ML
DT003ML
DT002ML
DT001ML
89.2
85.6
93.8
89.5
91.4
37.3
94.8
94.9
95.9
99.1
100
94.8
95
85
81
97.5
98.2
91.9
94.4
96.4
94.4
100
99.2
98.8
0
20
40
60
80
100
120
140
Percent of Miles Reported

Figure A.2-2



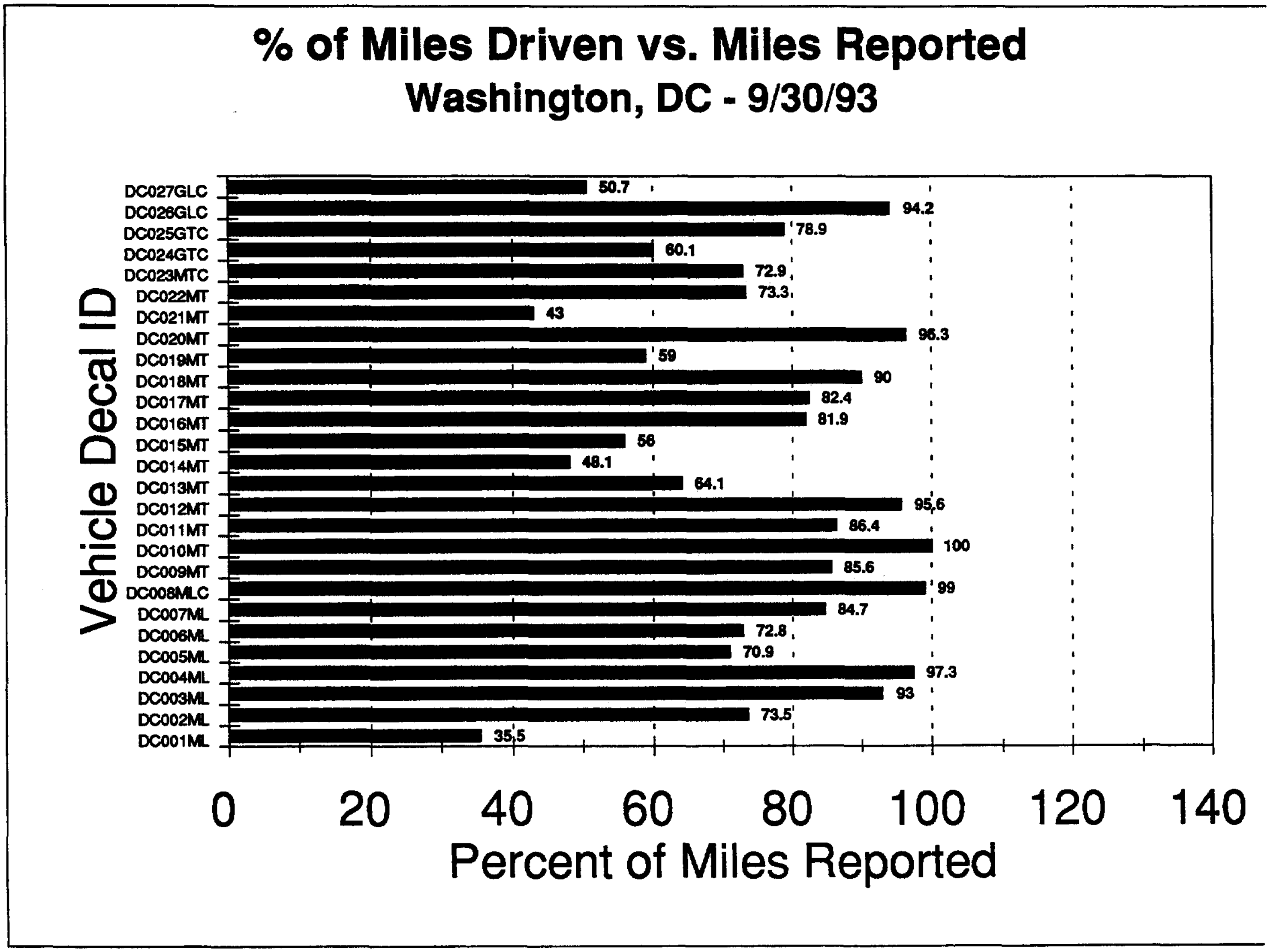
% of Miles Driven vs. Miles Reported
Los Angeles, CA - 9/30/93
Vehicle Decal ID
LA015GLC
LA014GLC
LA013GTC
LA012GTC
LA011MTC
LA010MT
LA009MT
LA008MT
LA007MT
LA006MLC
LA005ML
LA004ML
LA003ML
LA002ML
LA001ML
78.1
86.7
90.1
98.9
99.3
95.2
94.5
99.3
97.3
100
100
93.8
100
96.6
87.2
0
20
40
60
80
100
120
140
Percent of Miles Reported

Figure A.2-3



% of Miles Driven vs. Miles Reported
San Diego, CA - 9/30/93
Vehicle Decal ID
SD015GLC
SD014GLC
SD013GTC
SD012GTC
SD011MTC
SD010MT
SD009MT
SD008MT
SD007MT
SD006MLC
SD005ML
SD004ML
SD003ML
SD002ML
SD001ML
99.5
94.8
99.4
84.2
95.2
96.9
98.8
100
98.8
98.7
98.9
98.1
76
99.7
99.5
0
20
40
60
80
100
120
140
Percent of Miles Reported

Figure A.2-4



% of Miles Driven vs. Miles Reported
Washington, DC - 9/30/93
Vehicle Decal ID
DC027GLC
DC026GLC
DC025GTC
DC024GTC
DC023MTC
DC022MT
DC021MT
DC020MT
DC019MT
DC018MT
DC017MT
DC016MT
DC015MT
DC014MT
DC013MT
DC012MT
DC011MT
DC010MT
DC009MT
DC008MLC
DC007ML
DC006ML
DC005ML
DC004ML
DC003ML
DC002ML
DC001ML
50.7
94.2
78.9
60.1
72.9
73.3
43
96.3
59
90
82.4
81.9
56
48.1
64.1
95.6
86.4
100
85.6
99
84.7
72.8
70.9
97.3
93
73.5
35.5
0
20
40
60
80
100
120
140
Percent of Miles Reported

Figure A.2-5

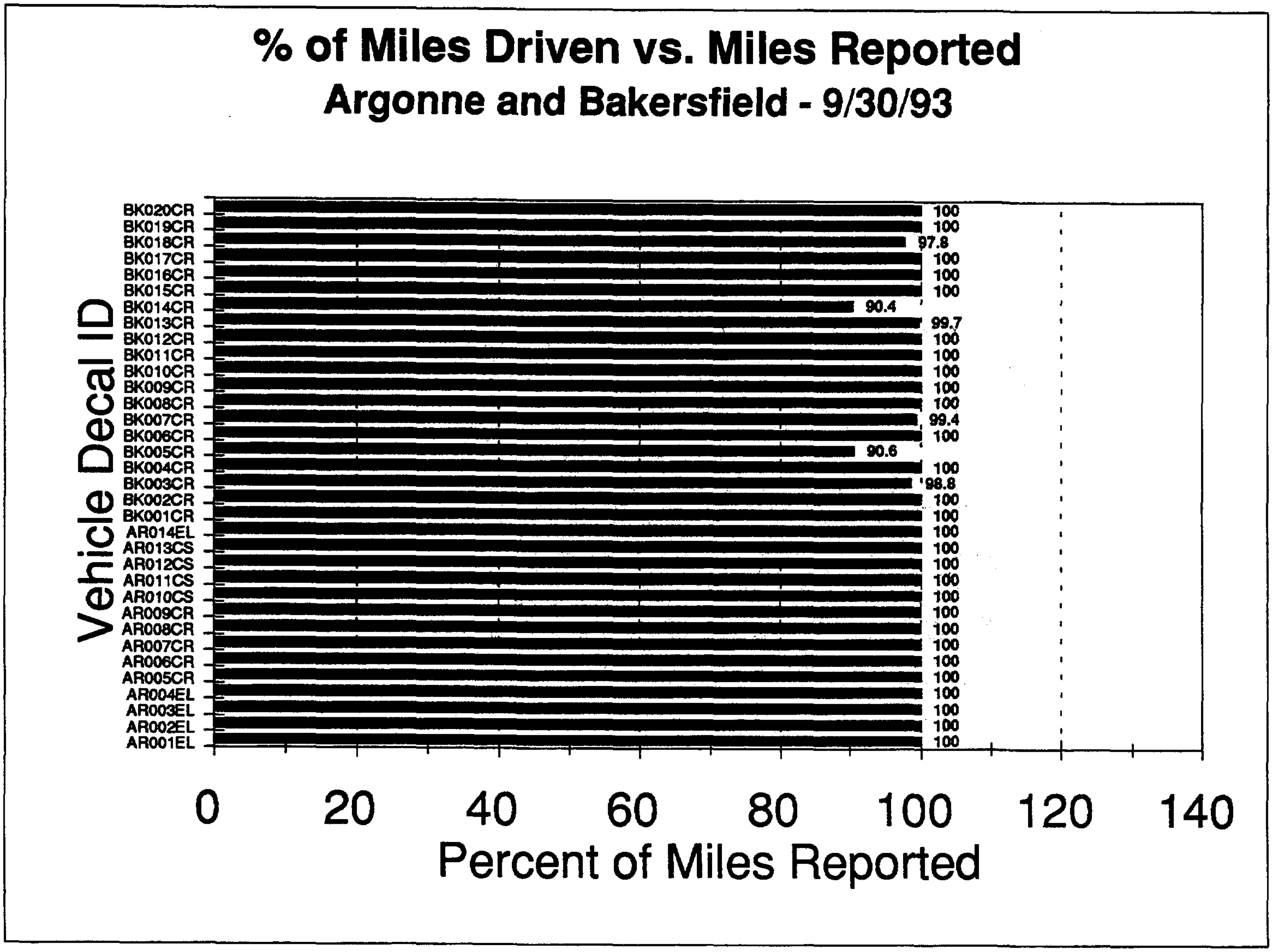

% of Miles Driven vs. Miles Reported
Argonne and Bakersfield - 9/30/93
Vehicle Decal ID
BK020CR 100
BK019CR 100
BK018CR 97.8
BK017CR 100
BK016CR 100
BK015CR 100
BK014CR 90.4
BK013CR 99.7
BK012CR 100
BK011CR 100
BK010CR 100
BK009CR 100
BK008CR 100
BK007CR 99.4
BK006CR 100
BK005CR 90.6
BK004CR 100
BK003CR 98.8
BK002CR 100
BK001CR 100
AR014EL 100
AR013CS 100
AR012CS 100
AR011CS 100
AR010CS 100
AR009CR 100
AR008CR 100
AR007CR 100
AR006CR 100
AR005CR 100
AR004EL 100
AR003EL 100
AR002EL 100
AR001EL 100
0 20 40 60 80 100 120 140
Percent of Miles Reported

Figure A.2-6

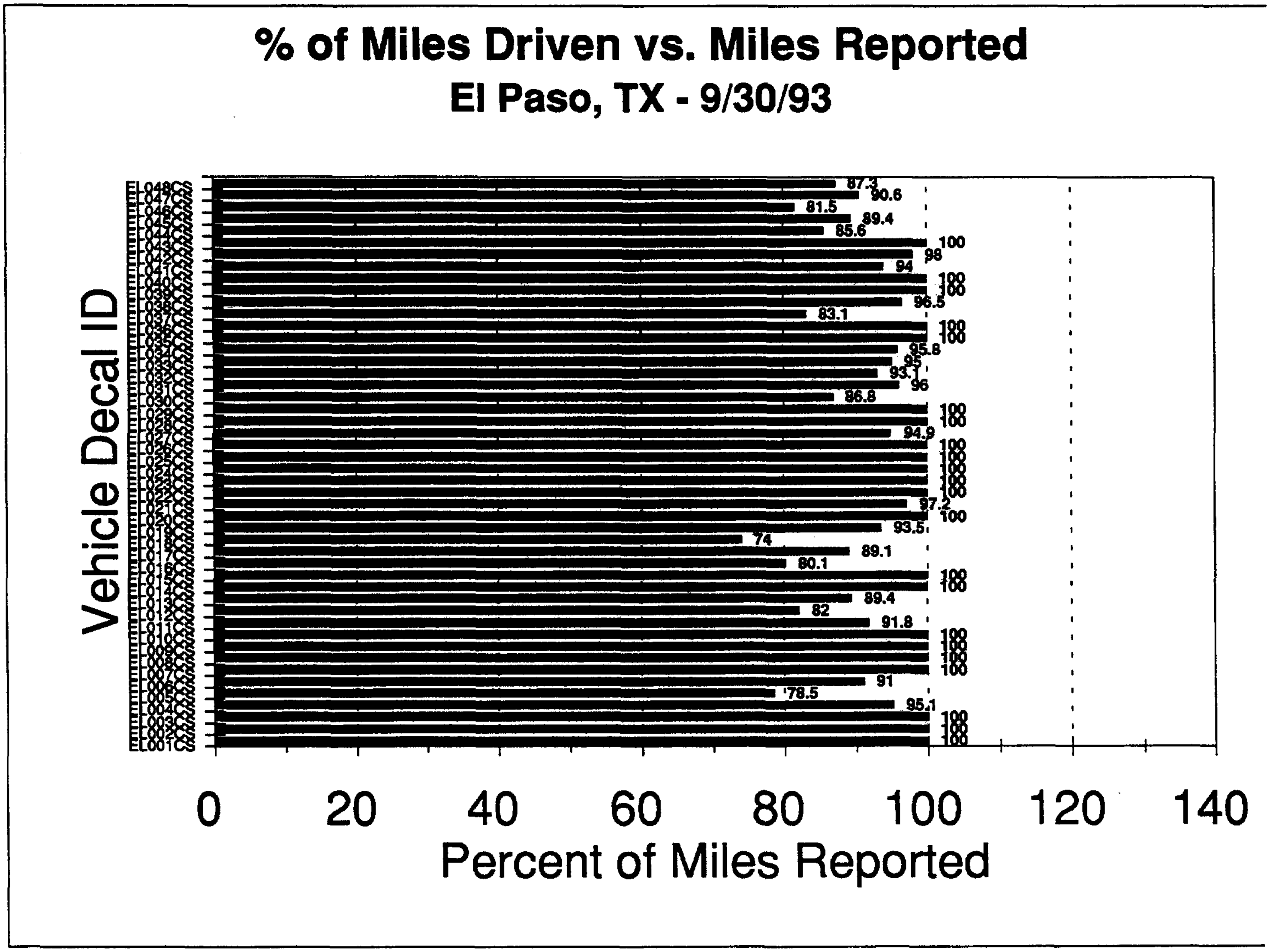

% of Miles Driven vs. Miles Reported
El Paso, TX - 9/30/93
Vehicle Decal ID
EL048CS
EL001CS
0
20
40
60
80
100
120
140
Percent of Miles Reported

Figure A.2-7. Light Duty Vehicle Data Log for Detroit

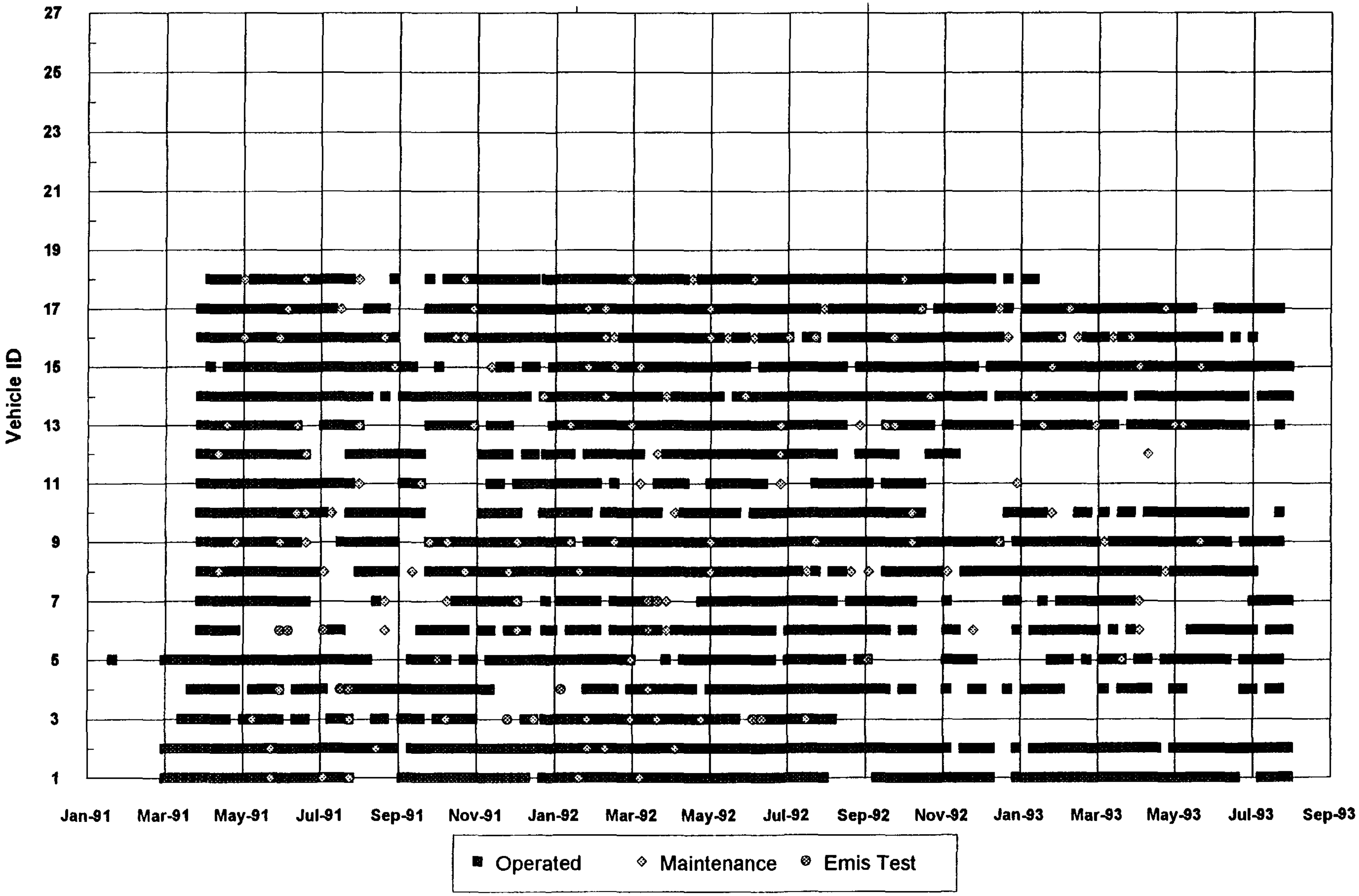


Figure A.2-8. Light Duty Vehicle Data Log for Los Angeles

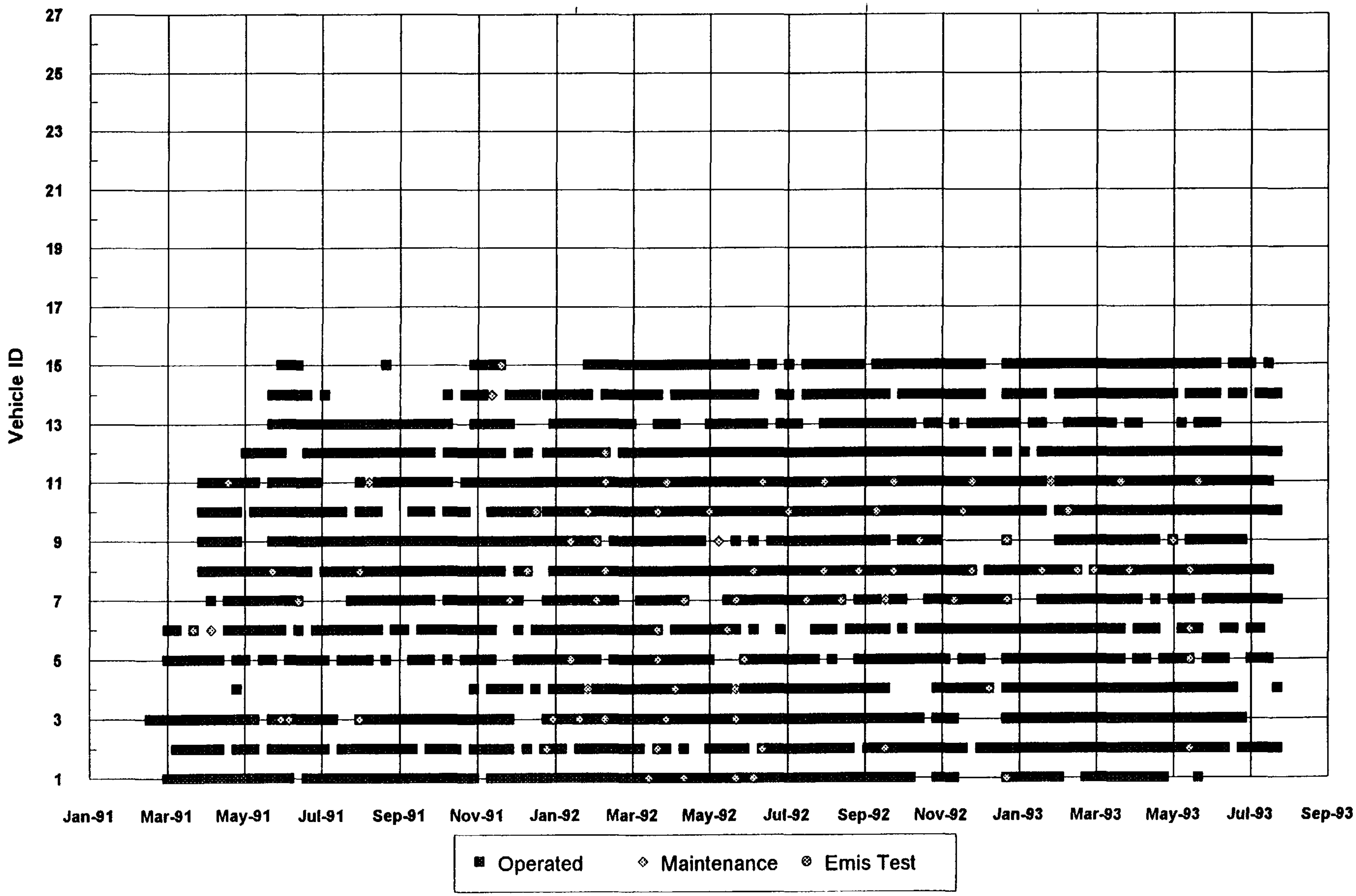


Figure A.2-9. Light Duty Vehicle Data Log for San Diego

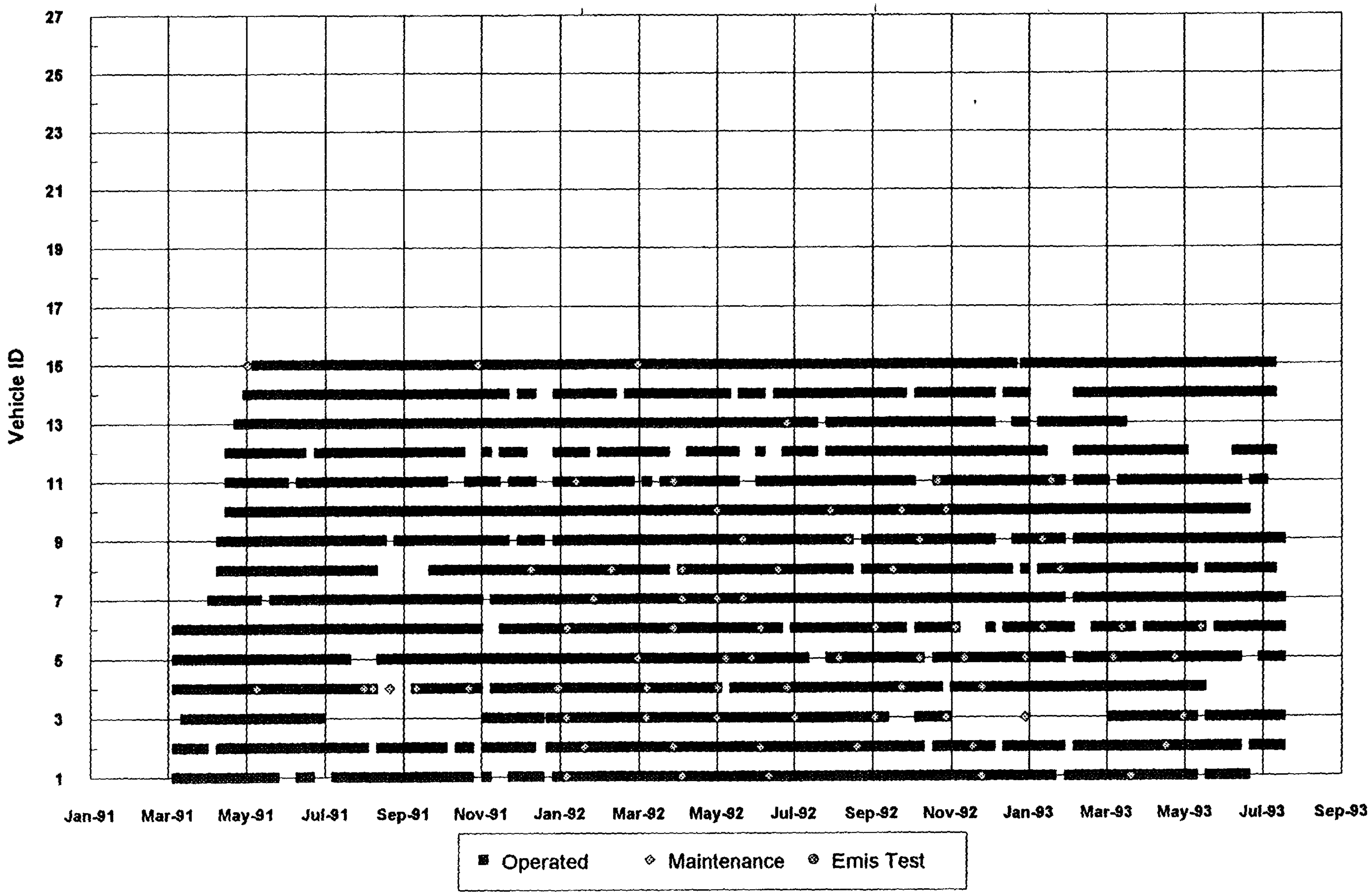


Figure A.2-10. Light Duty Vehicle Data Log for Washington DC

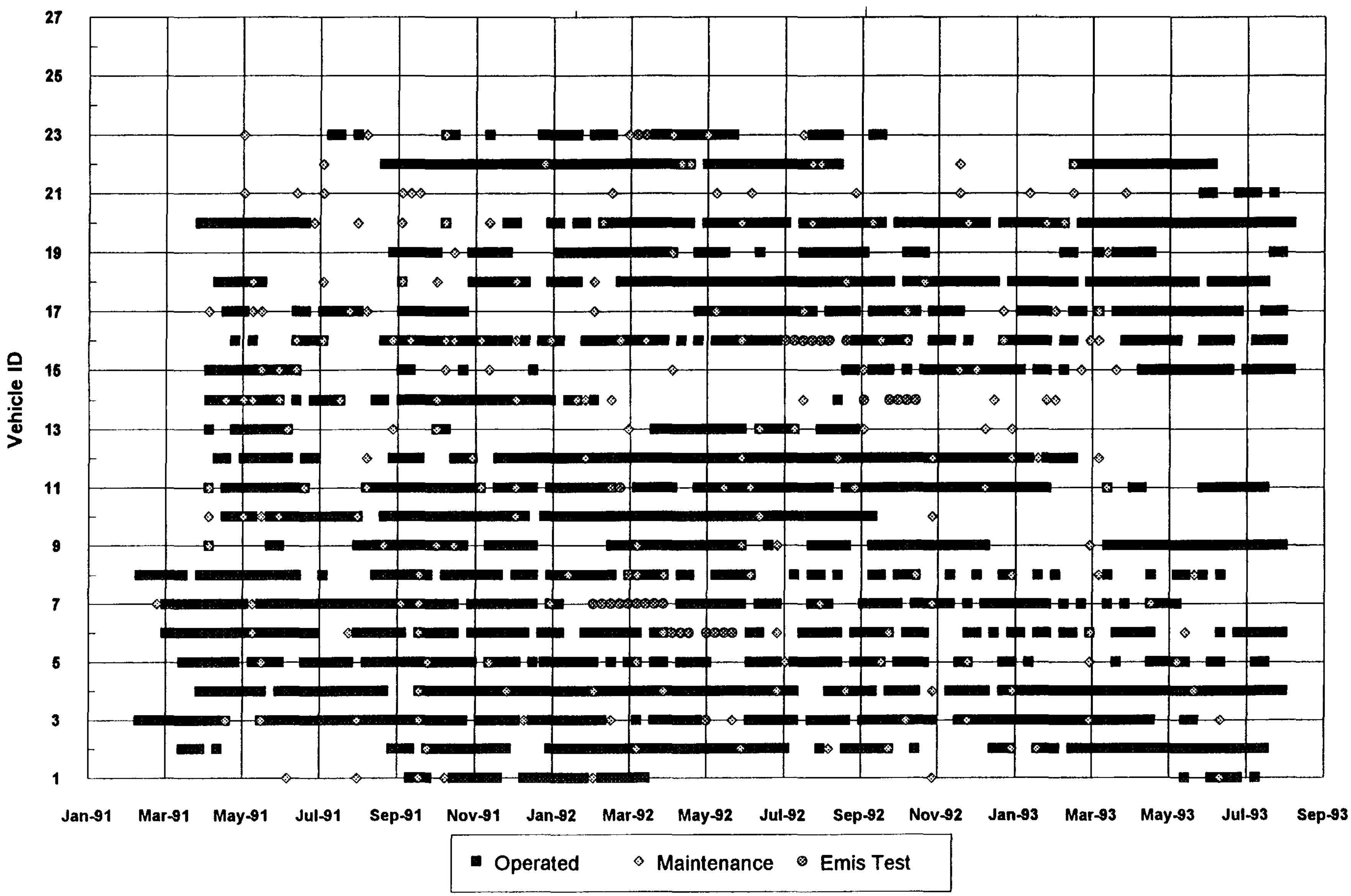


Figure A.2-11. Light Duty Vehicle Data Log for Argonne

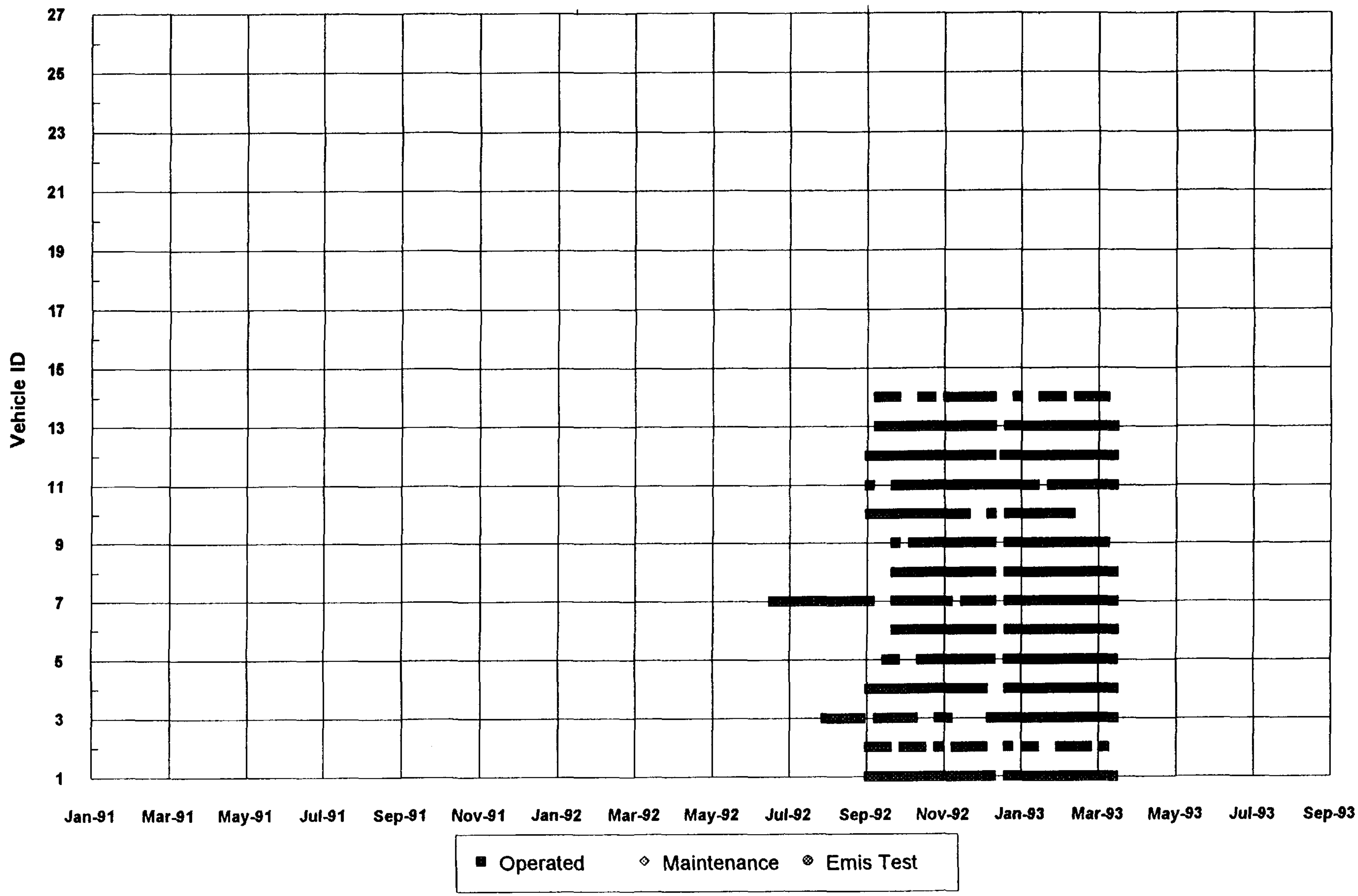


Figure A.2-12. Light Duty Vehicle Data Log for Bakersfield

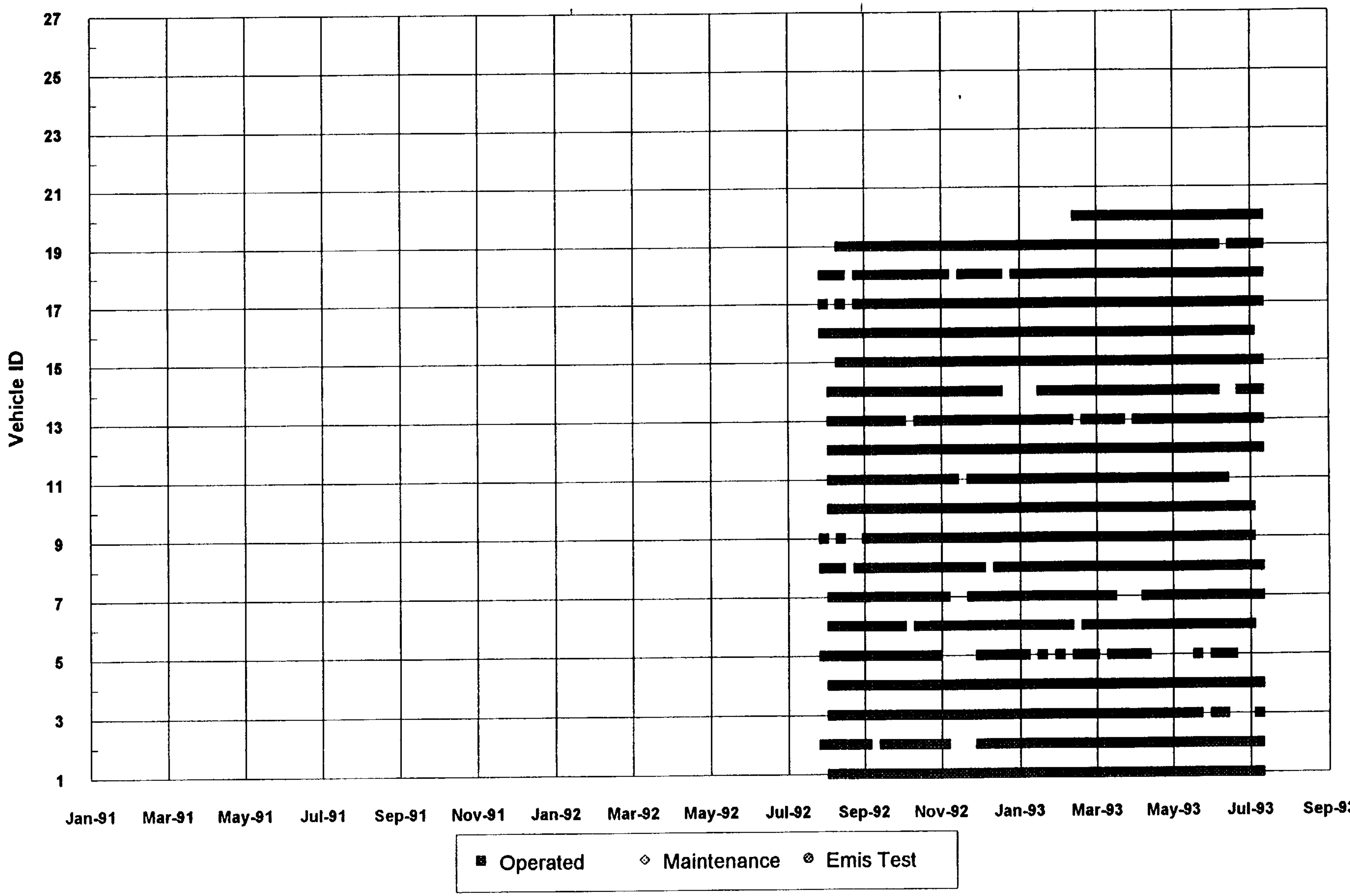


Figure A.2-13. Light Duty Vehicle Data Log for El Paso

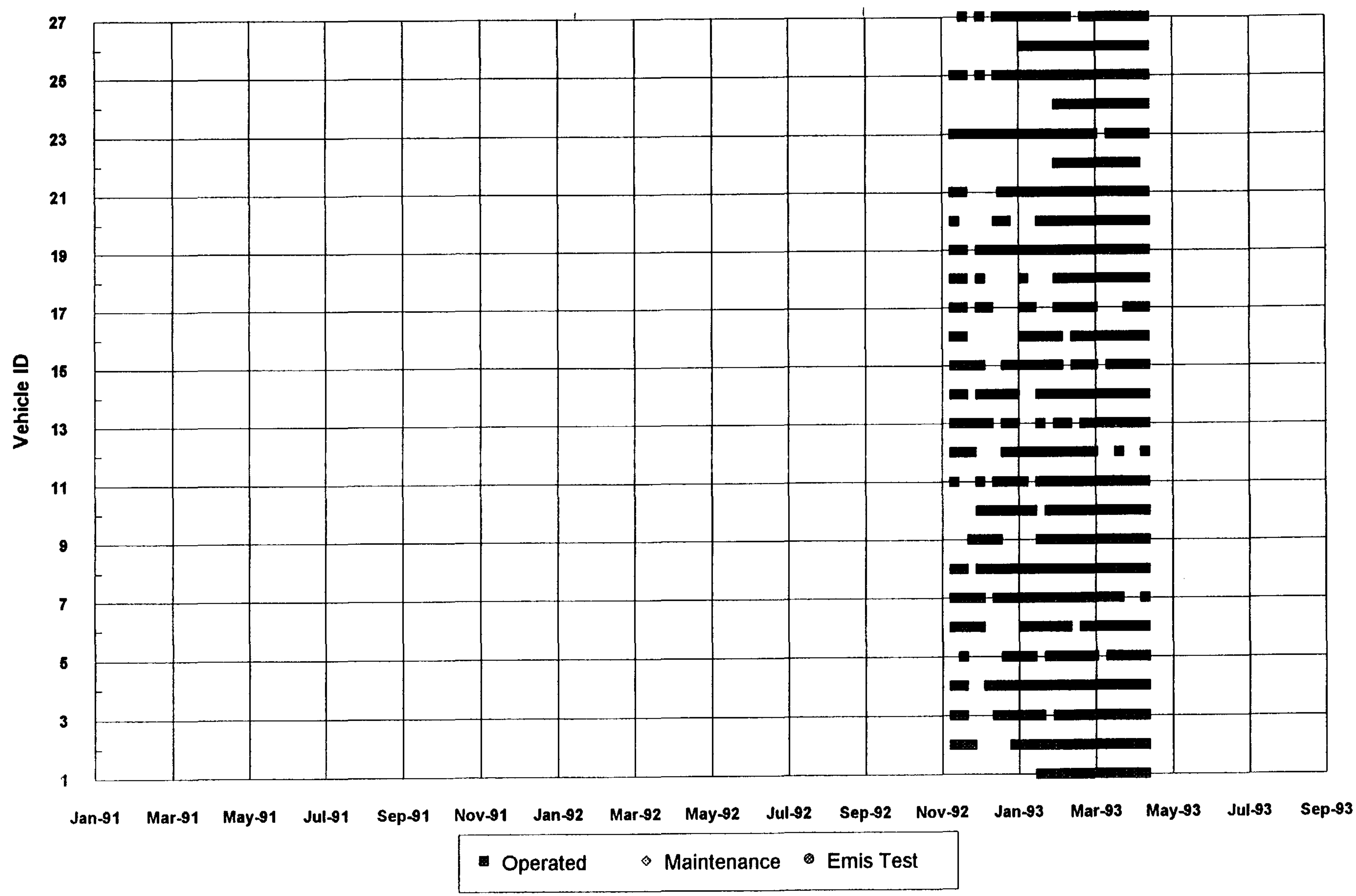
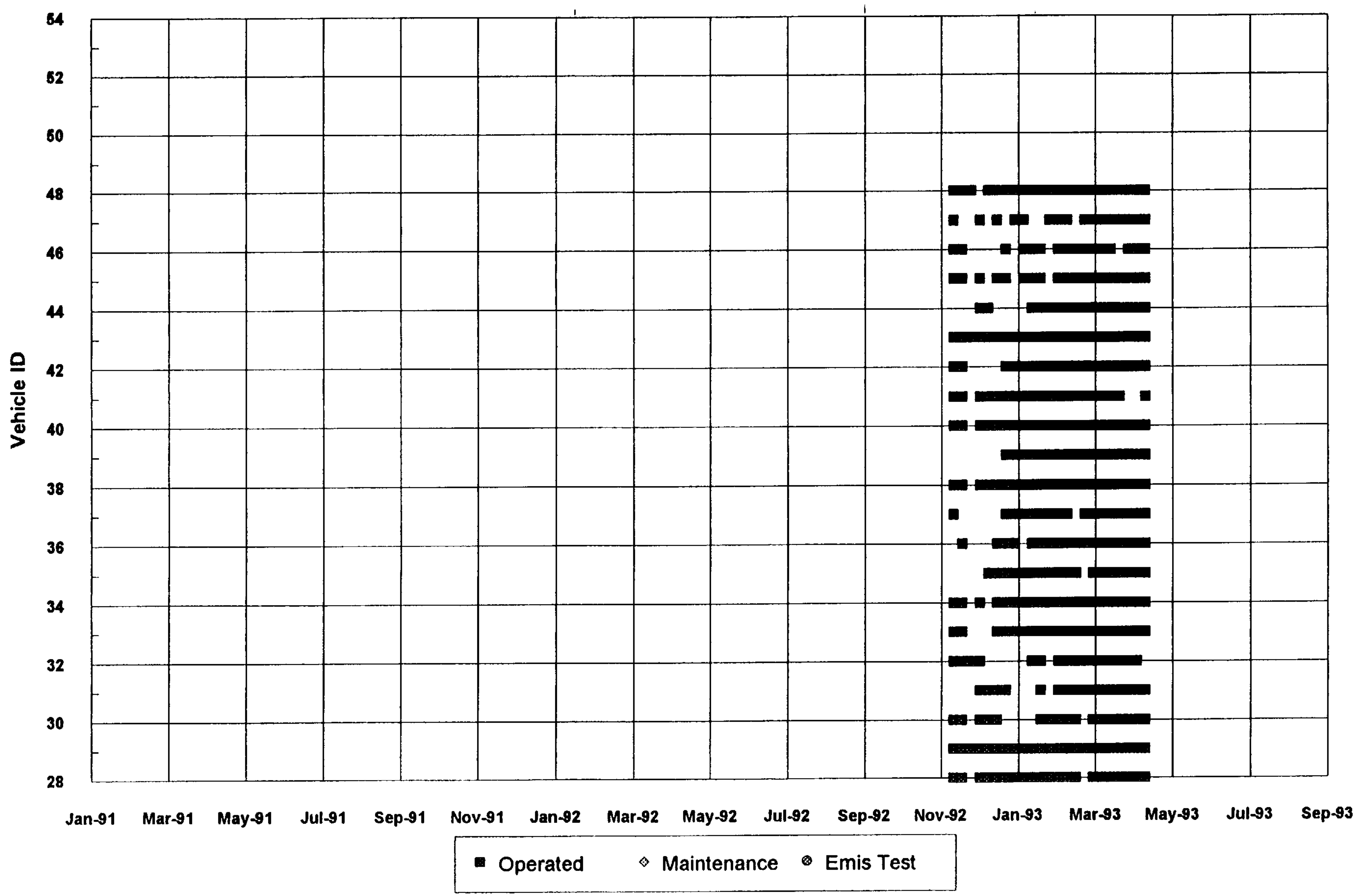


Figure A.2-14. Light Duty Vehicle Data Log for El Paso



Appendix

Fuel Economy Analysis
Section 3

Figure A.3-1

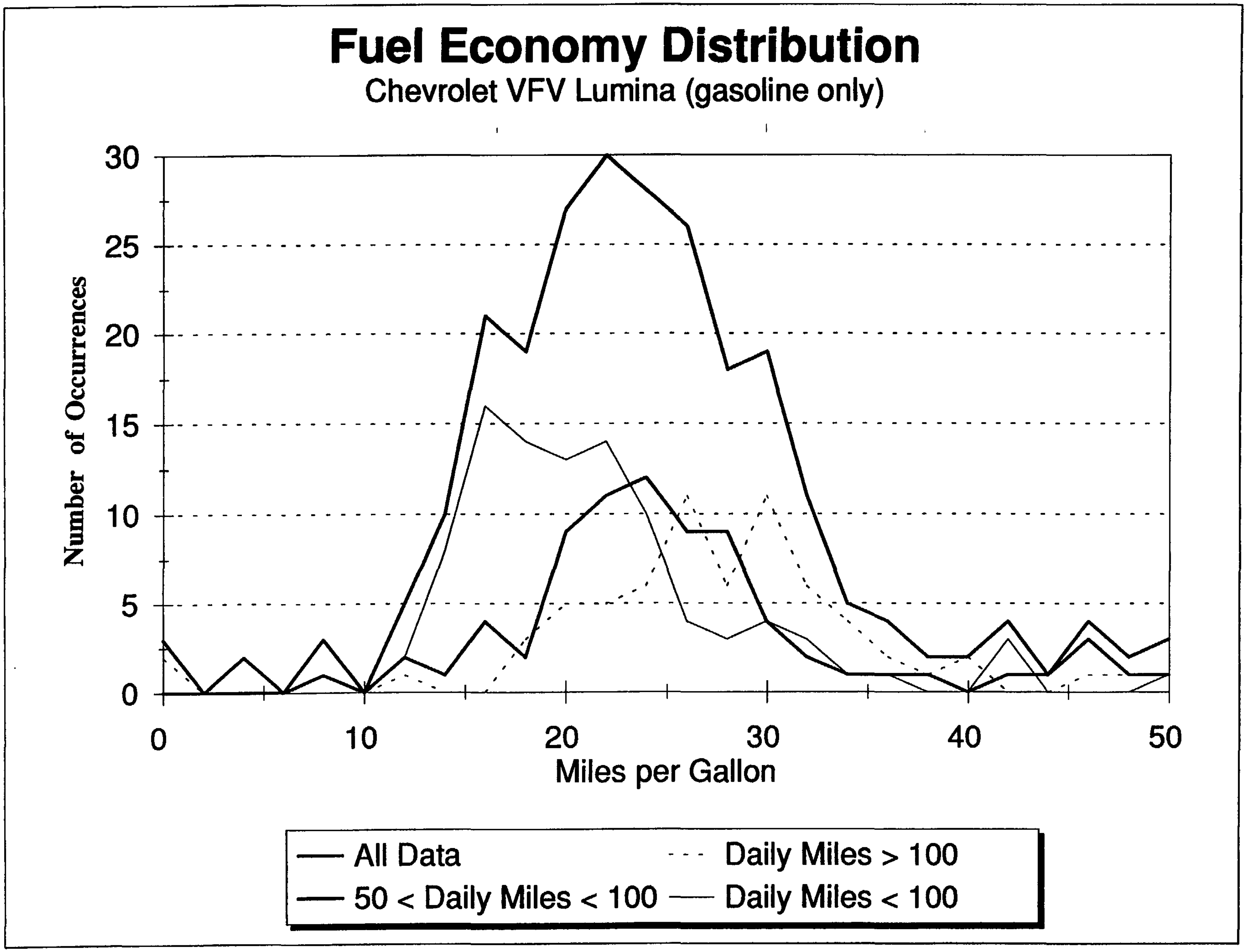
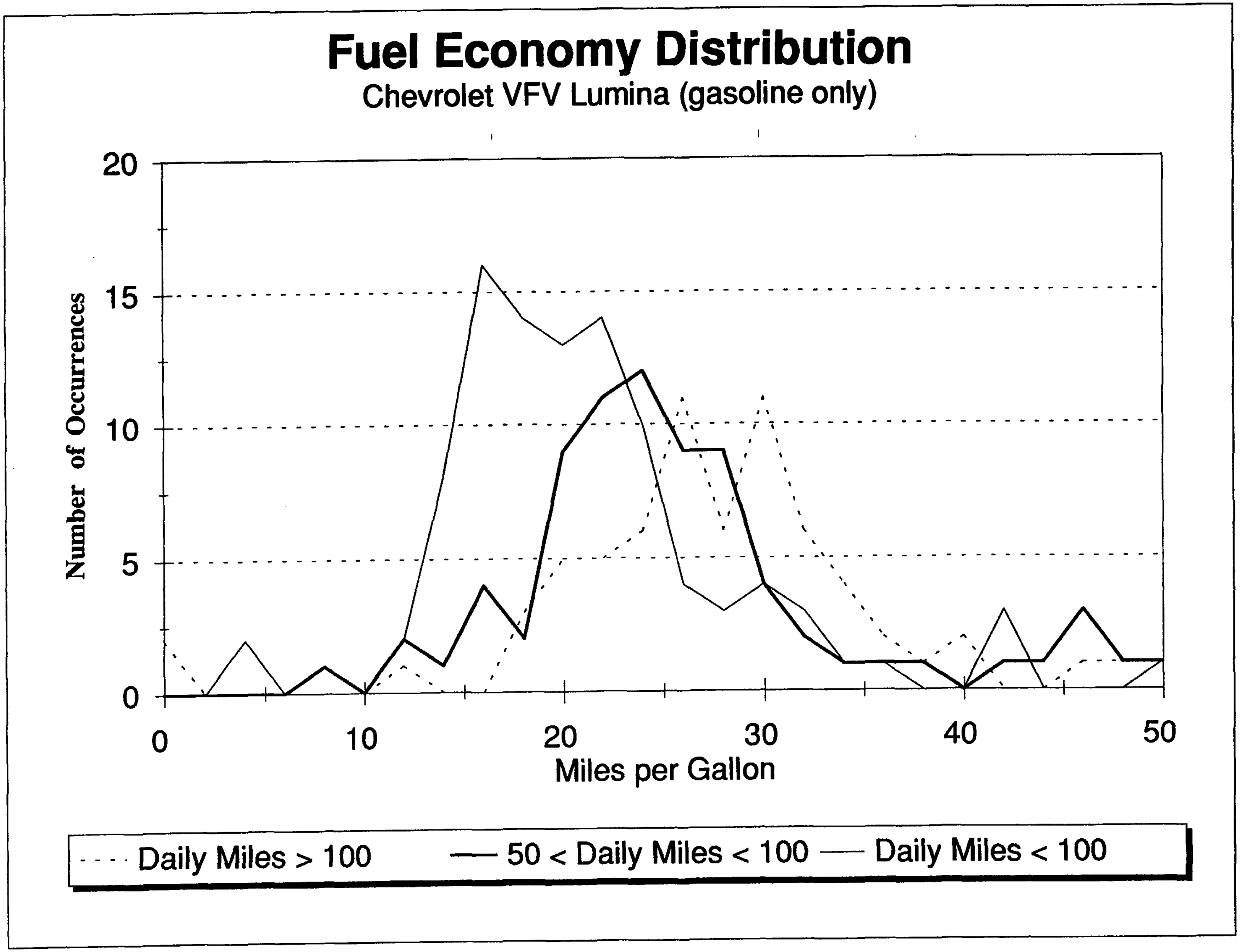

Fuel Economy Distribution
Chevrolet VFV Lumina (gasoline only)
Number of Occurrences
30
25
20
15
10
5
0
0
10
20
30
40
50
Miles per Gallon
All Data
50 < Daily Miles < 100
Daily Miles > 100
Daily Miles < 100

Figure A.3-2



Fuel Economy Distribution
Chevrolet VFV Lumina (gasoline only)
Number of Occurrences
20
15
10
5
0
0
10
20
30
40
50
Miles per Gallon
Daily Miles > 100
50 < Daily Miles < 100
Daily Miles < 100

Figure A.3-3

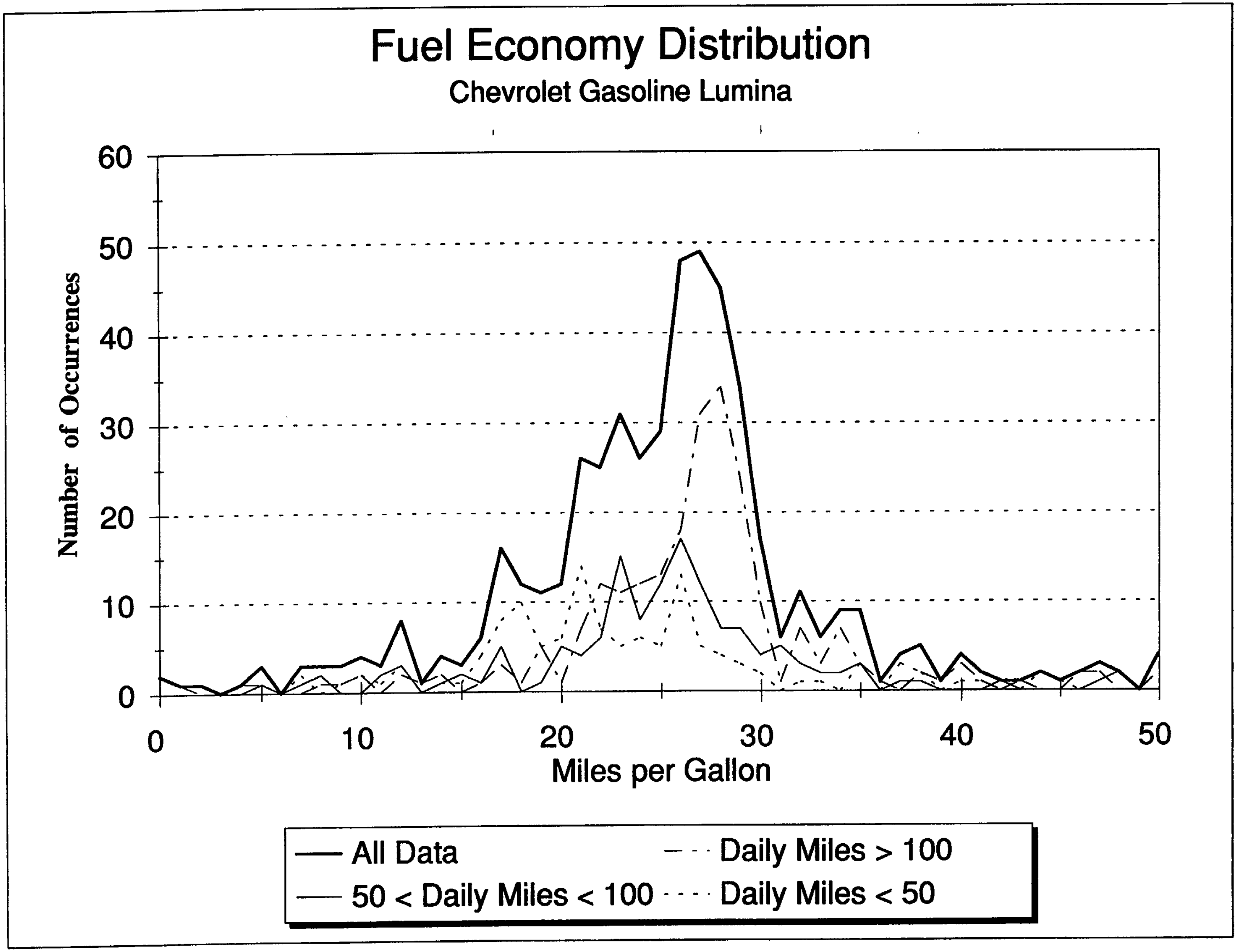

Fuel Economy Distribution
Chevrolet Gasoline Lumina
Number of Occurrences
60
50
40
30
20
10
0
0
10
20
30
40
50
Miles per Gallon
All Data
Daily Miles > 100
50 < Daily Miles < 100
Daily Miles < 50

Figure A.3-4

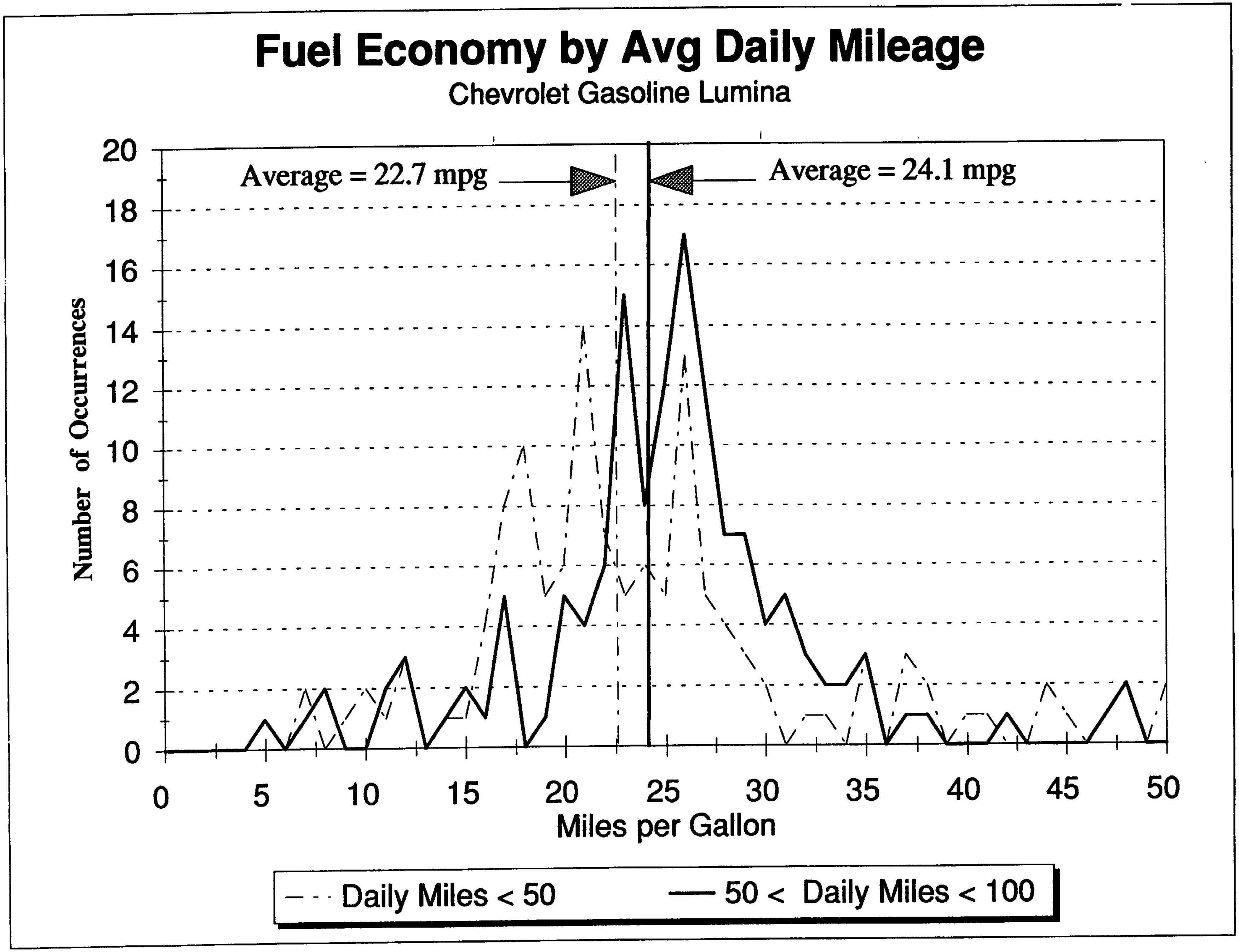

Fuel Economy by Avg Daily Mileage
Chevrolet Gasoline Lumina
Average = 22.7 mpg
Average = 24.1 mpg
Number of Occurrences
0
2
4
6
8
10
12
14
16
18
20
0
5
10
15
20
25
30
35
40
45
50
Miles per Gallon
Daily Miles < 50
50 < Daily Miles < 100

Figure A.3-5

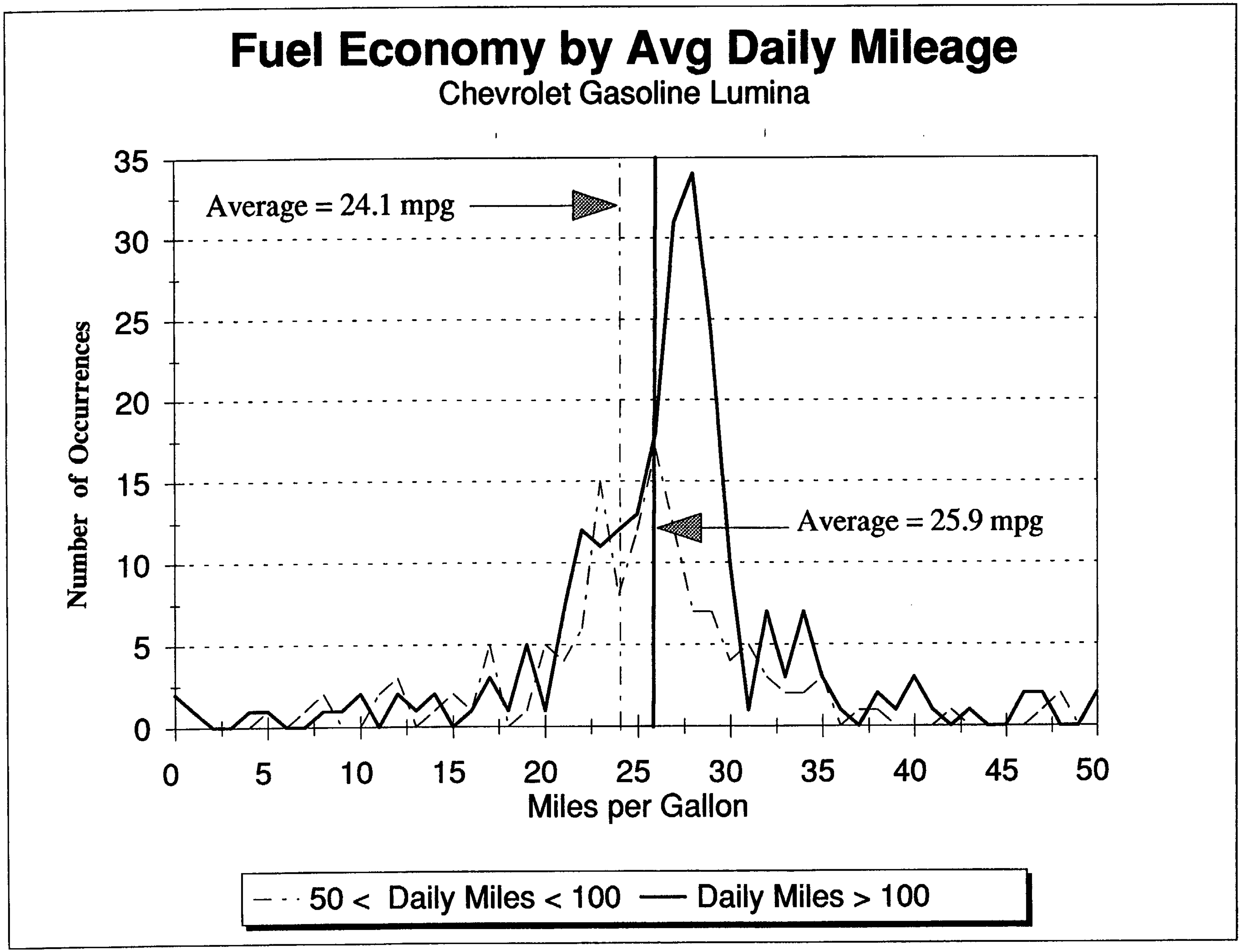

Fuel Economy by Avg Daily Mileage
Chevrolet Gasoline Lumina
Average = 24.1 mpg
Average = 25.9 mpg
Number of Occurrences
35
30
25
20
15
10
5
0
0
5
10
15
20
25
30
35
40
45
50
Miles per Gallon
50 < Daily Miles < 100
Daily Miles > 100

Figure A.3-6

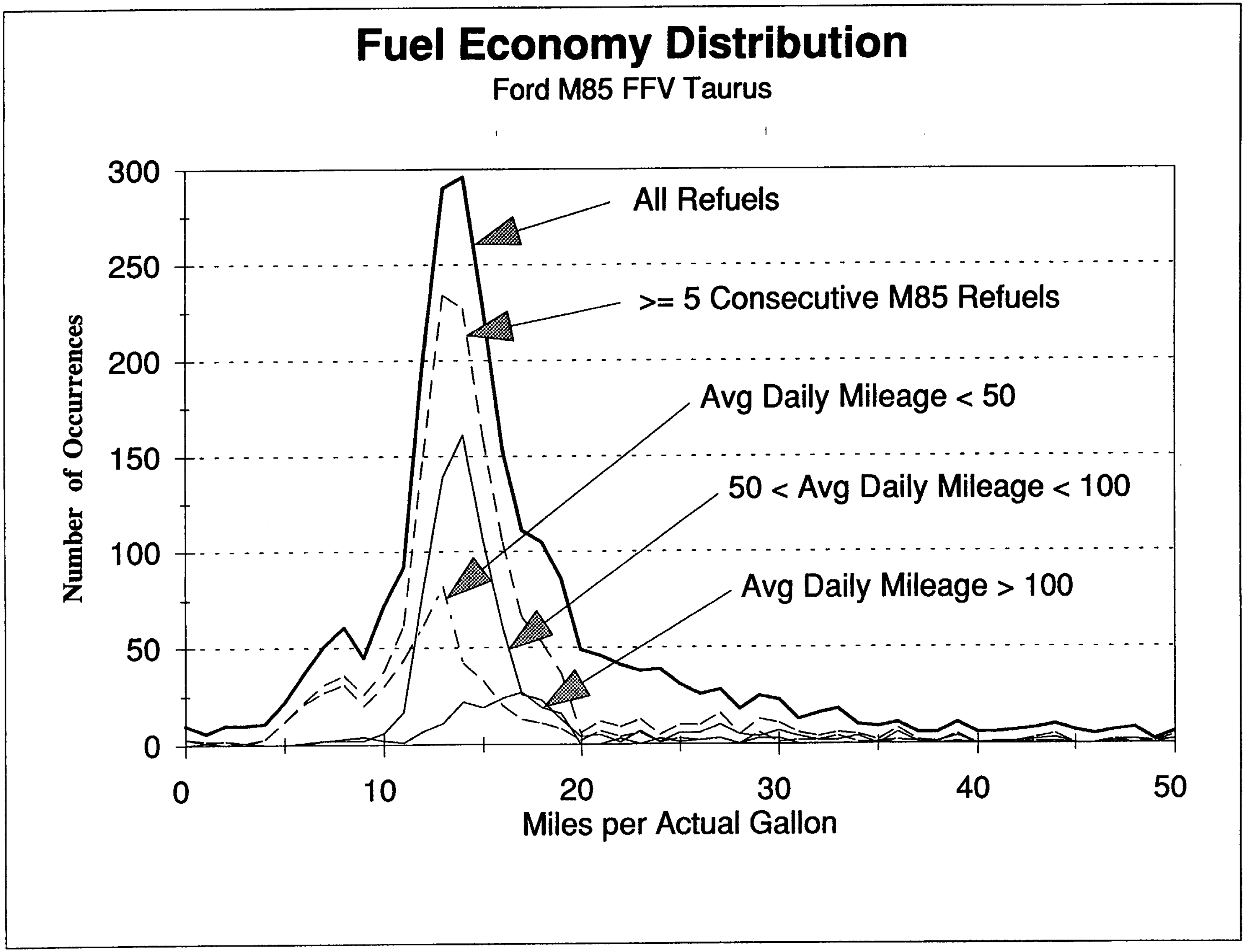
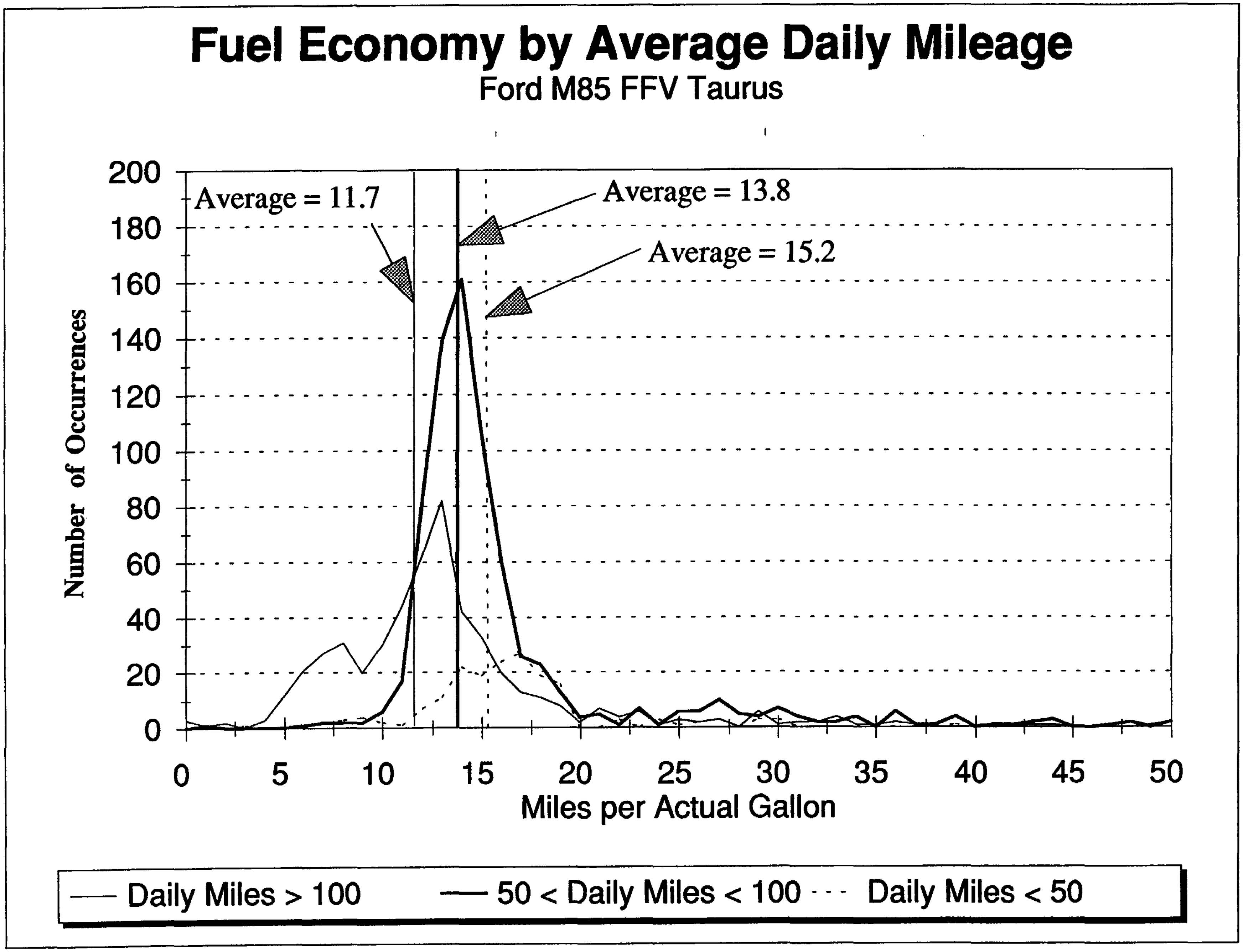
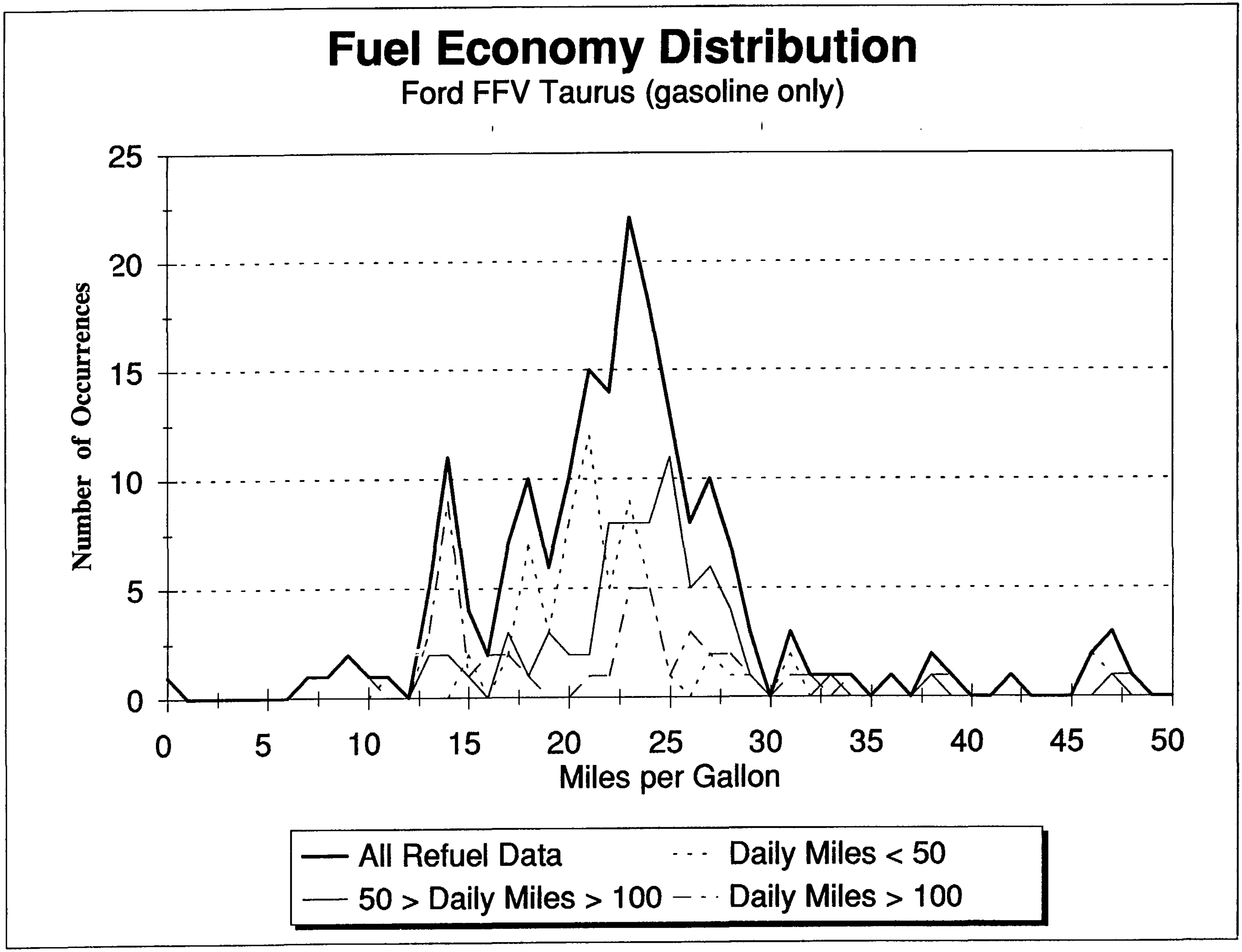

Fuel Economy Distribution
Ford M85 FFV Taurus
All Refuels
>= 5 Consecutive M85 Refuels
Avg Daily Mileage < 50
50 < Avg Daily Mileage < 100
Avg Daily Mileage > 100
Number of Occurrences
300
250
200
150
100
50
0
0
10
20
30
40
50
Miles per Actual Gallon

Figure A.3-7



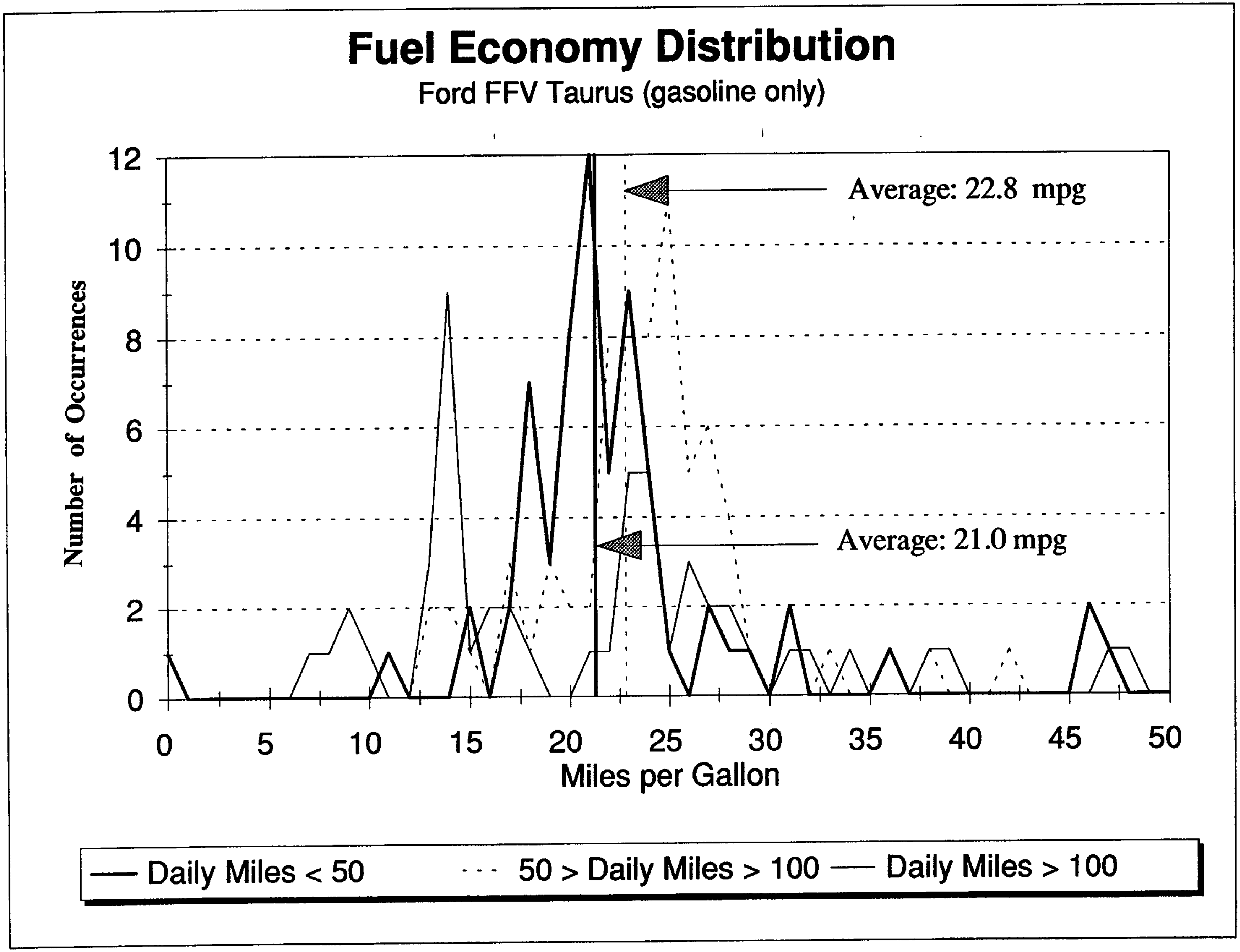
Fuel Economy by Average Daily Mileage
Ford M85 FFV Taurus
Average = 11.7
Average = 13.8
Average = 15.2
Number of Occurrences
200
180
160
140
120
100
80
60
40
20
0
0
5
10
15
20
25
30
35
40
45
50
Miles per Actual Gallon
Daily Miles > 100
50 < Daily Miles < 100
Daily Miles < 50

Figure A.3-8



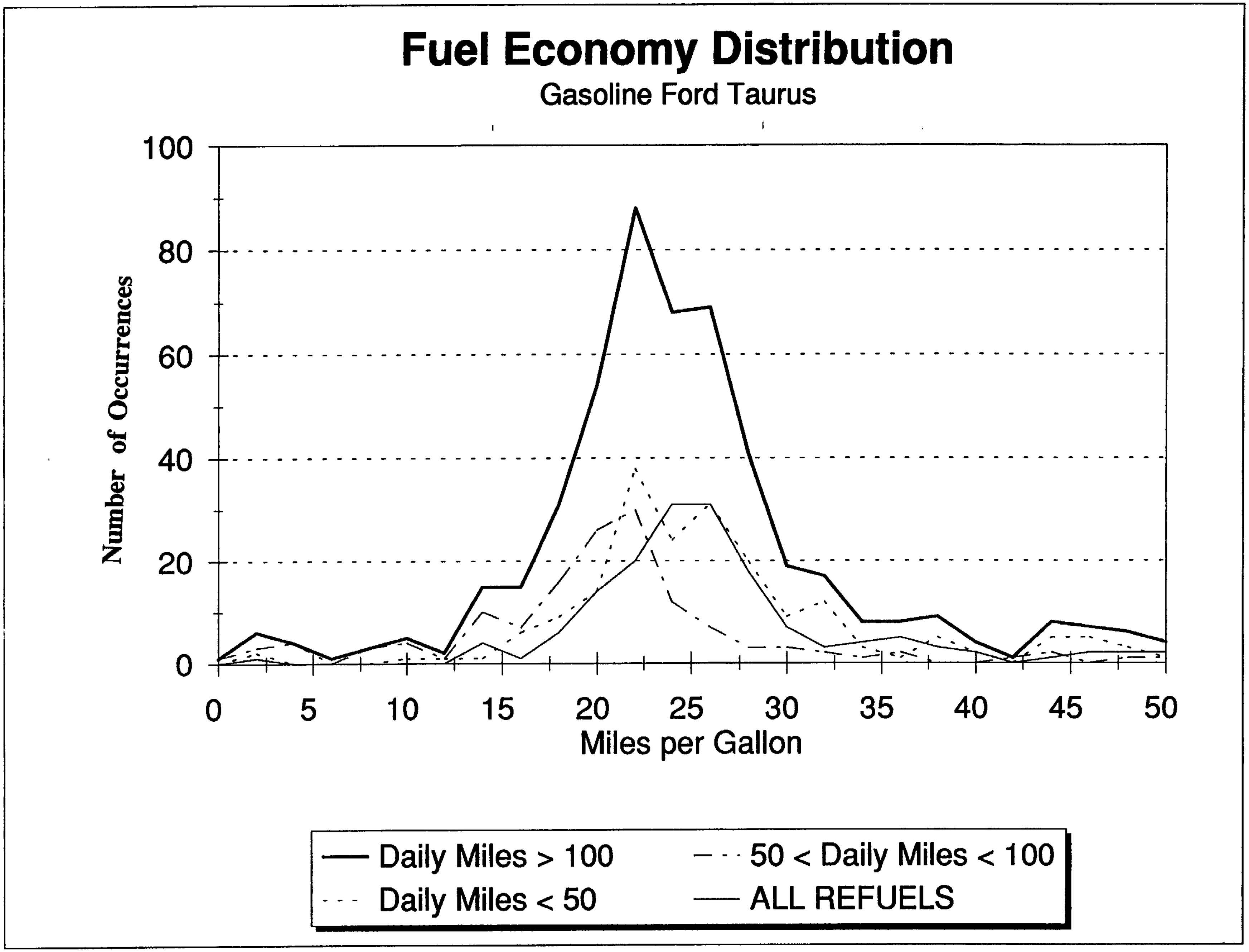
Fuel Economy Distribution
Ford FFV Taurus (gasoline only)
Number of Occurrences
25
20
15
10
5
0
0
5
10
15
20
25
30
35
40
45
50
Miles per Gallon
All Refuel Data
Daily Miles < 50
50 > Daily Miles > 100
Daily Miles > 100

Figure A.3-9



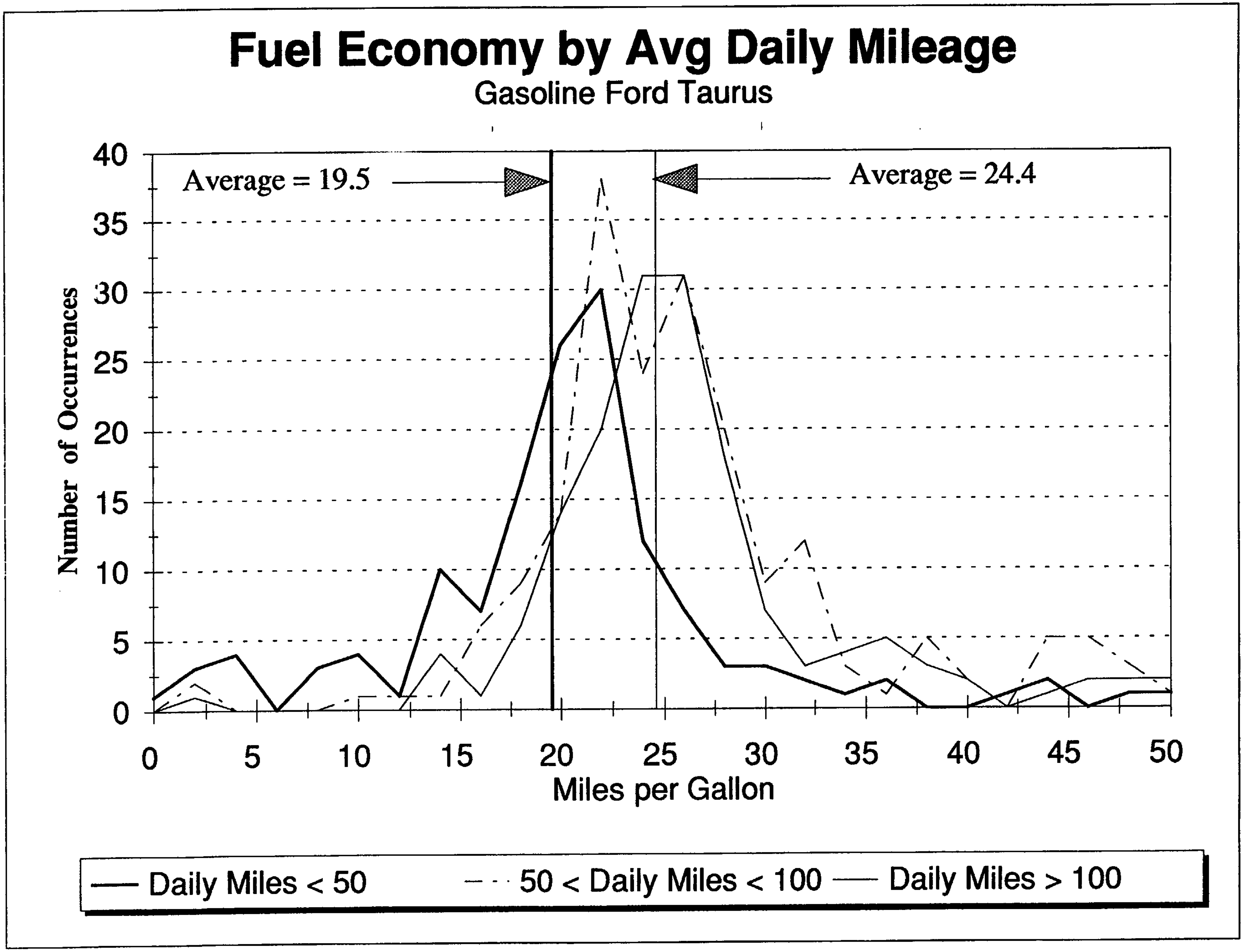
Fuel Economy Distribution
Ford FFV Taurus (gasoline only)
Average: 22.8 mpg
Average: 21.0 mpg
Number of Occurrences
0
2
4
6
8
10
12
0
5
10
15
20
25
30
35
40
45
50
Miles per Gallon
Daily Miles < 50
50 > Daily Miles > 100
Daily Miles > 100

Figure A.3-10



Fuel Economy Distribution
Gasoline Ford Taurus
100
80
60
40
20
0
Number of Occurrences
0
5
10
15
20
25
30
35
40
45
50
Miles per Gallon
Daily Miles > 100
50 < Daily Miles < 100
Daily Miles < 50
ALL REFUELS

Figure A.3-11



Fuel Economy by Avg Daily Mileage
Gasoline Ford Taurus
Average = 19.5
Average = 24.4
Number of Occurrences
40
35
30
25
20
15
10
5
0
0
5
10
15
20
25
30
35
40
45
50
Miles per Gallon
Daily Miles < 50
50 < Daily Miles < 100
Daily Miles > 100

Appendix

Performance and Unscheduled Maintenance
Section 4

Figure A.4-1. Performance and Maintenance for Detroit

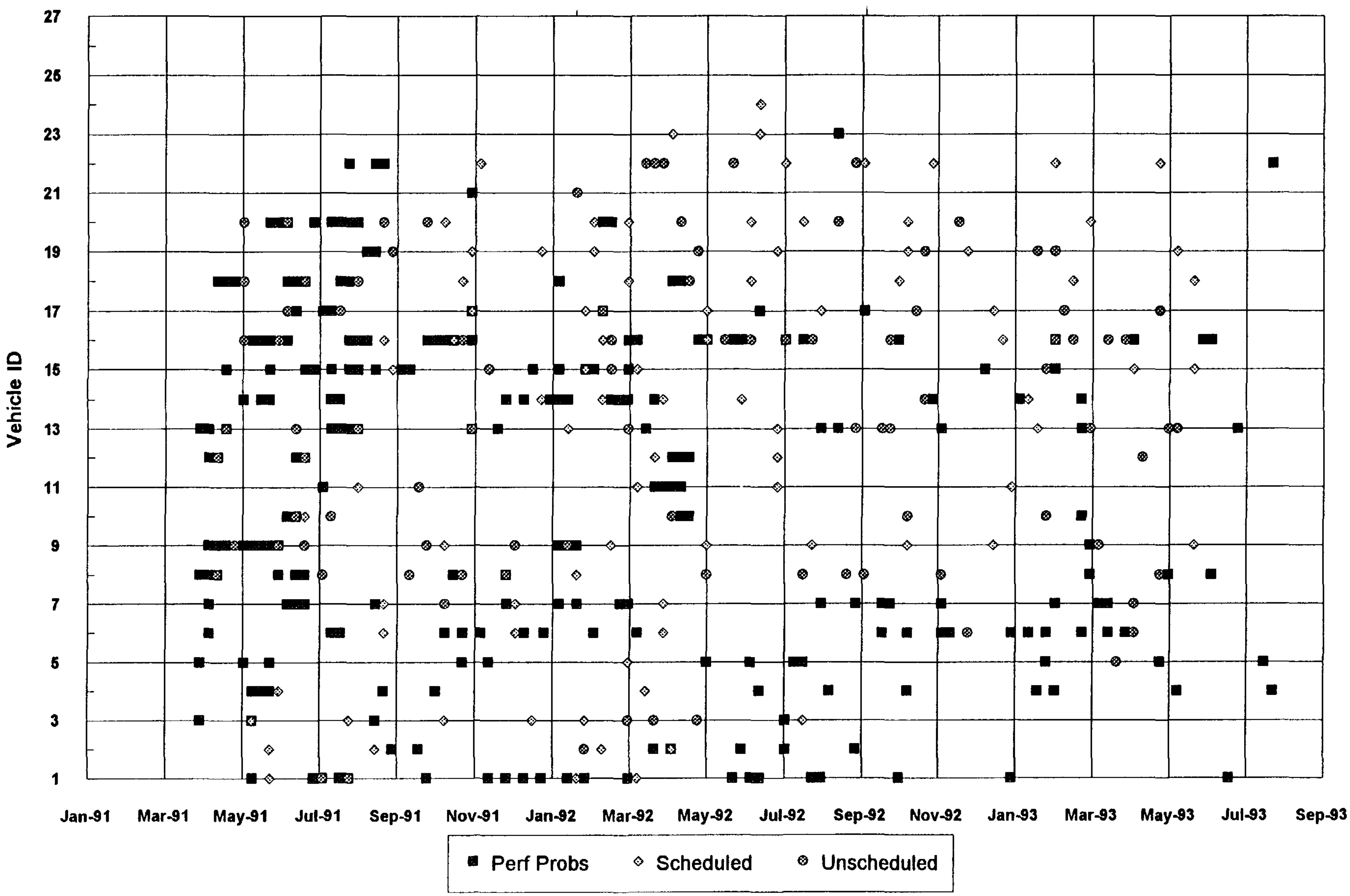


Figure A.4-2. Performance and Maintenance for Los Angeles

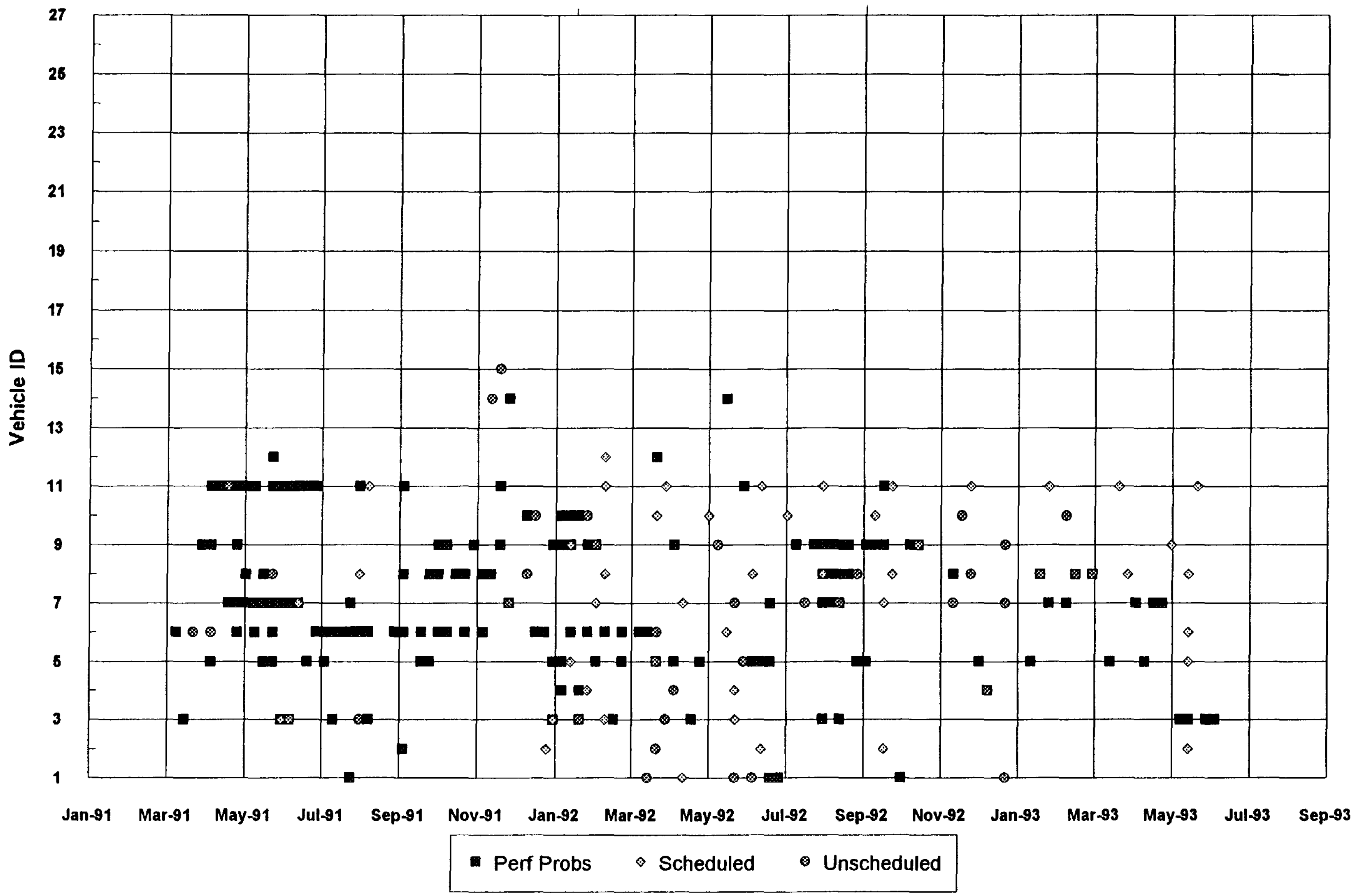


Figure A.4-3. Performance and Maintenance for San Diego

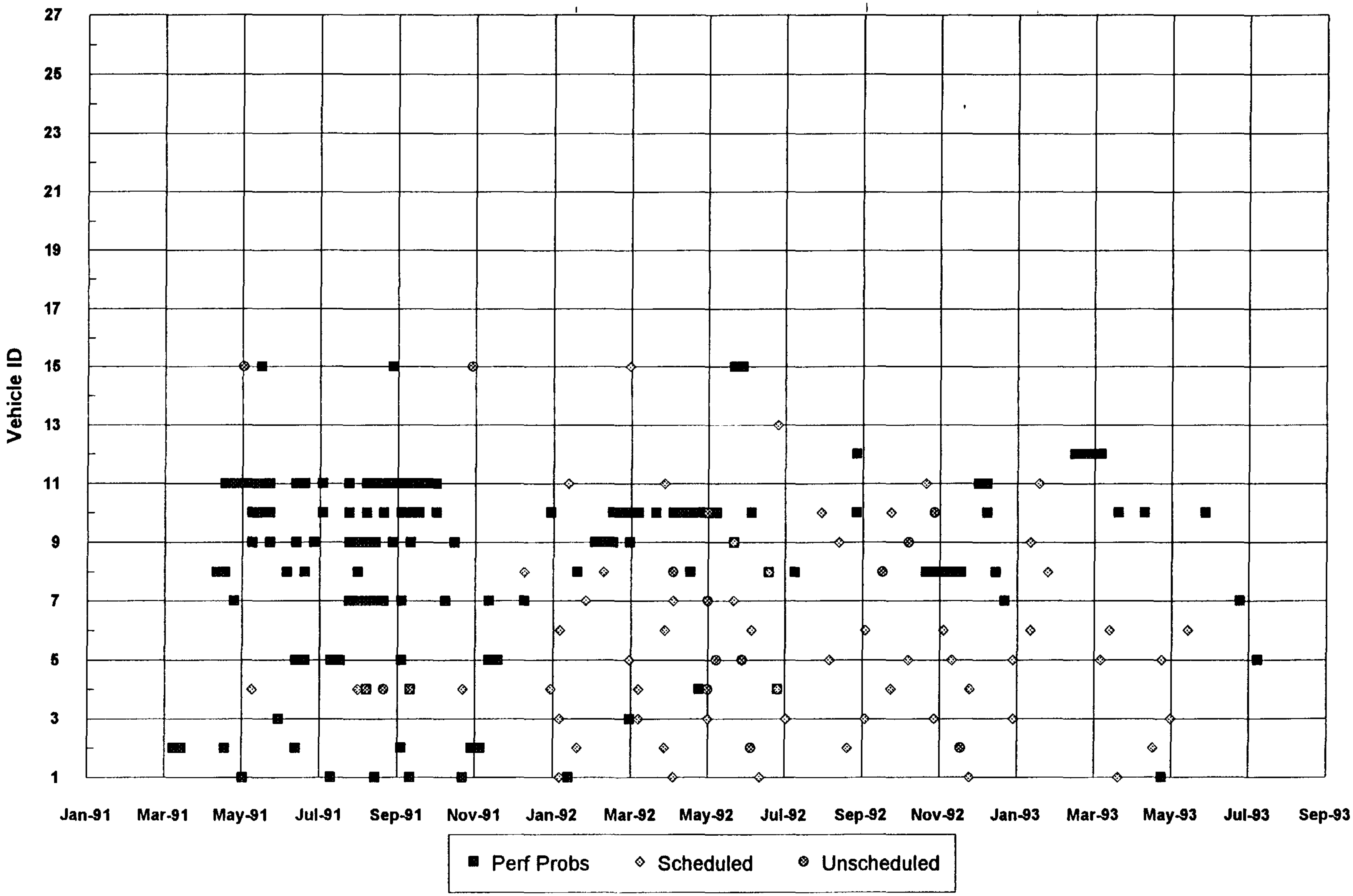


Figure A.4-4. Performance and Maintenance for Washington DC

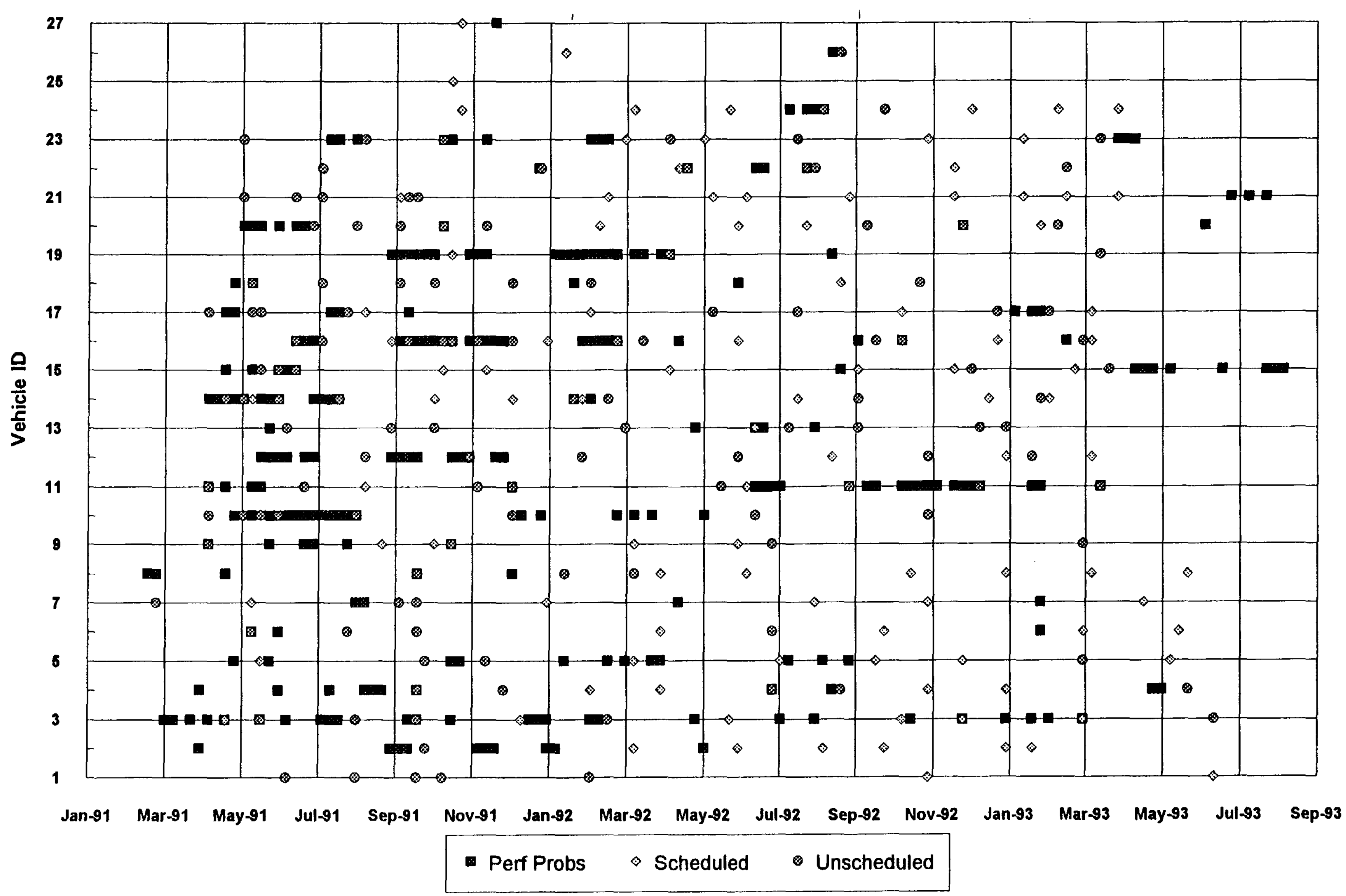


Figure A.4-5. Performance and Maintenance for Argonne

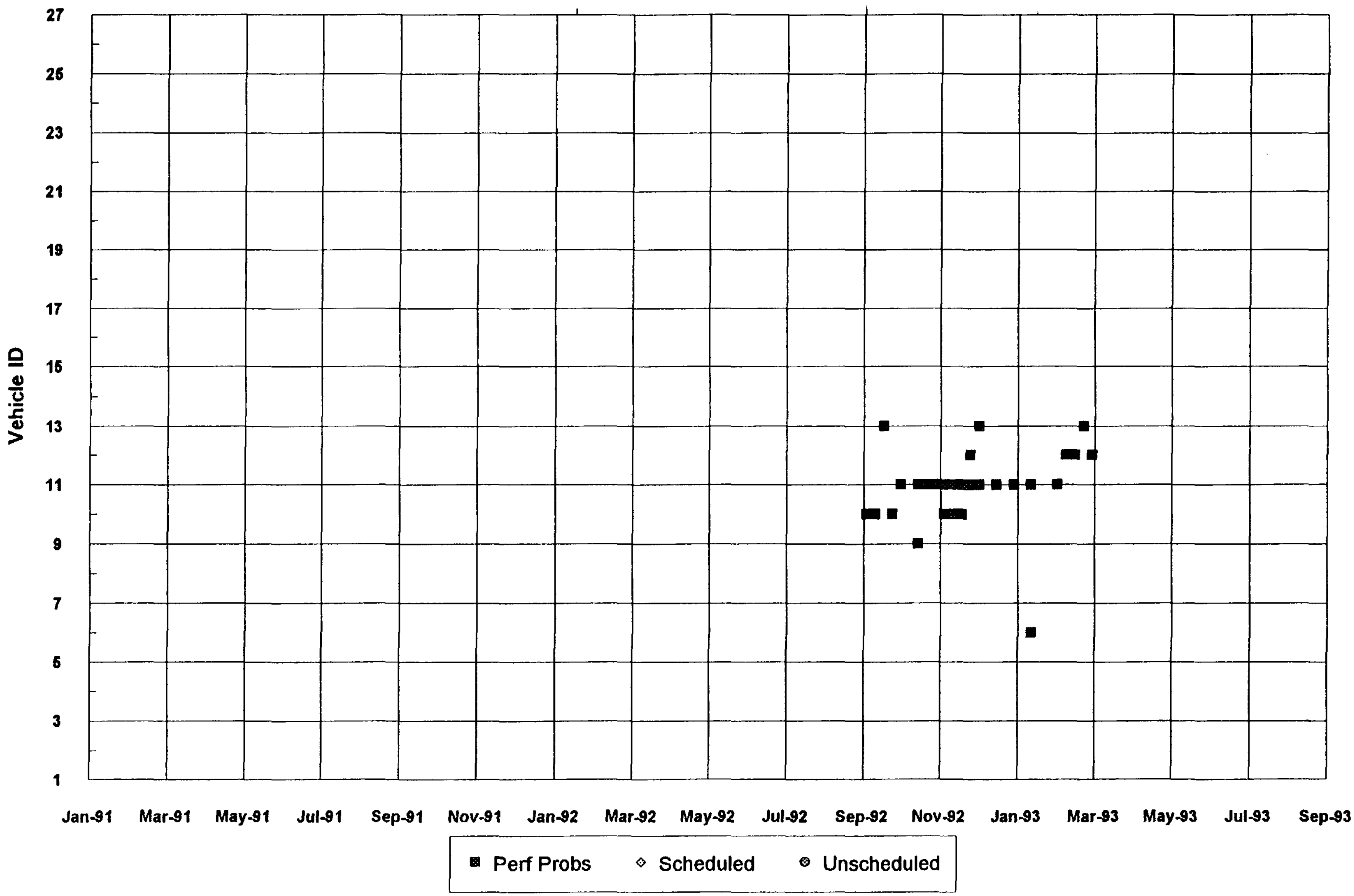


Figure A.4-6. Performance and Maintenance for Bakersfield

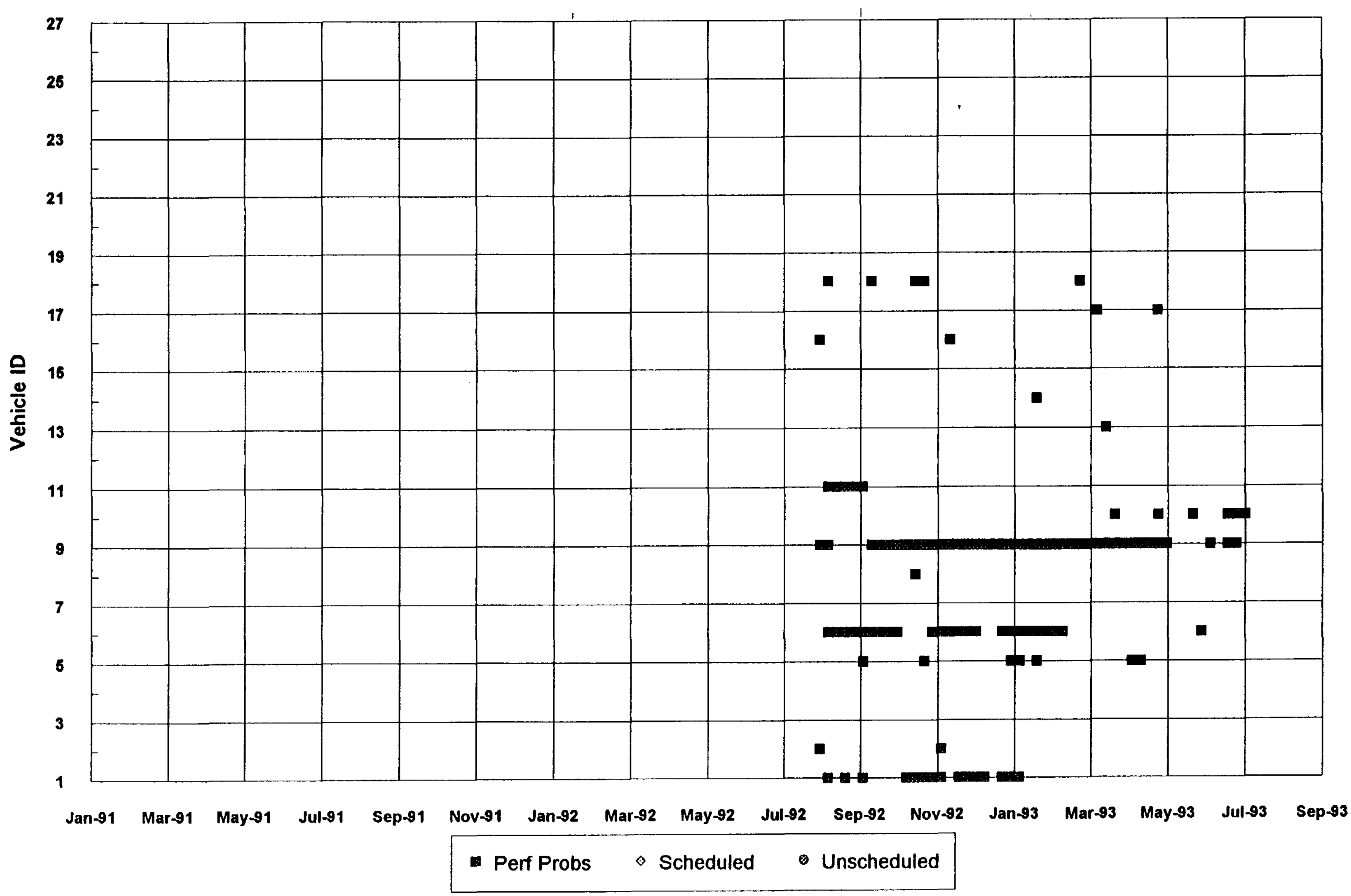


Figure A.4-7. Performance and Maintenance for El Paso

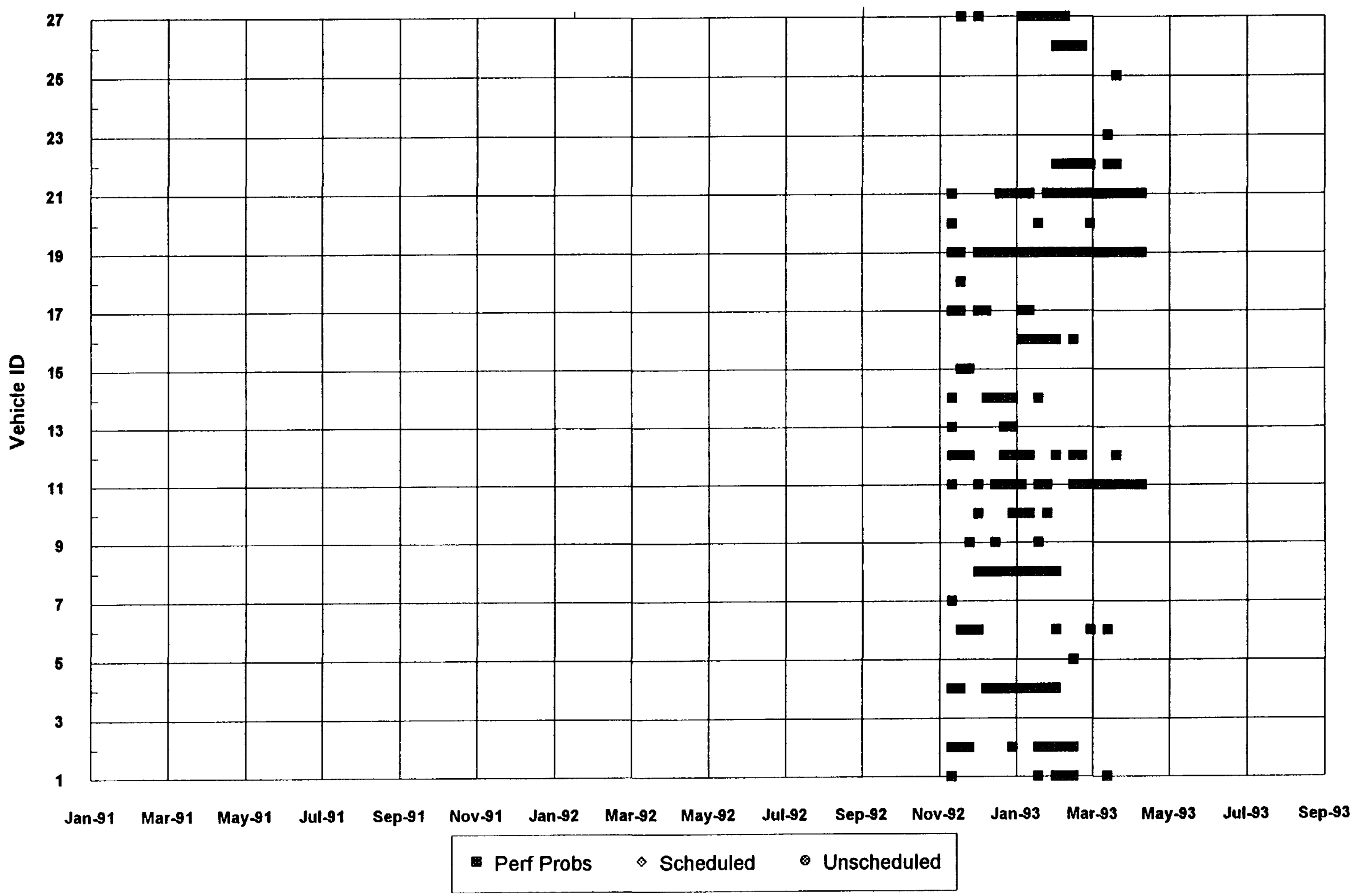
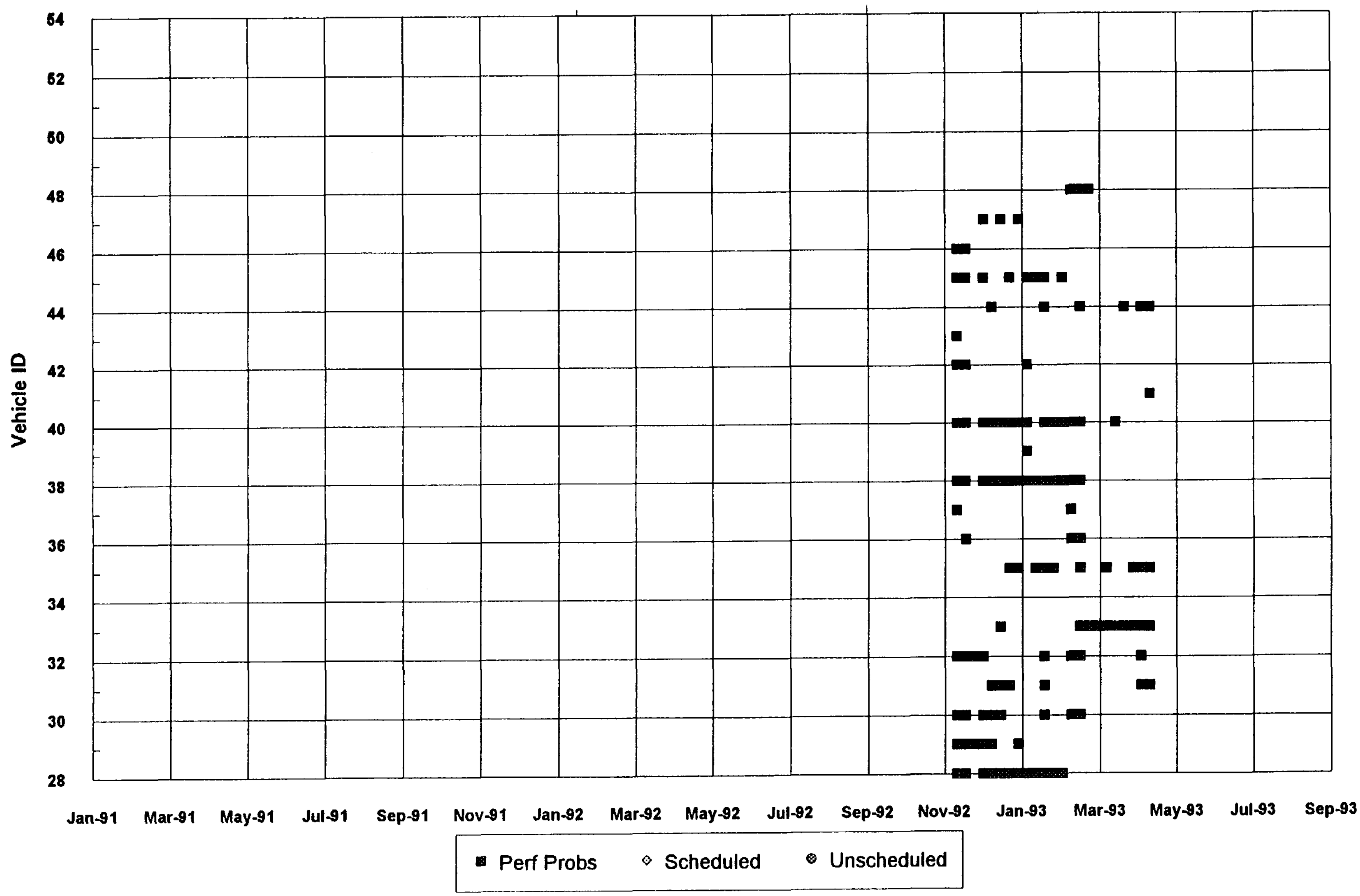


Figure A.4-8. Performance and Maintenance for El Paso



Appendix

Emissions Measurements
Section 5

Table A.5-1
Regression Parameters and Goodness of Fit
Correlation of FTP Emission Gas Concentrations to Vehicle Mileage

Figure No.	Line	Constant	Slope	R Squared
1. Exhaust CO - Indolene	Stock Lumina (all Points)	2.86	0.00011	0.166
	Stock Lumina (less 1 hi pt	1.77	0.000128	0.428
	VFV Lumina	1.412	0.000074	0.319
	VFV Lumina Control	1.6	0.000047	0.357
2.Exhaust CO - Indolene	Stock Taurus	2.316	0.000023	0.064
	FFV Taurus	2.143	0.000278	0.713
	FFV Taurus Control	3.37	0.000179	0.277
3. Exhaust CO - M85 Fuel	FFV Taurus	1.827	0.000121	0.358
	VFV Lumina	1.513	0.000242	0.917
4. Exhaust NOx - Indolene	Stock Lumina	0.2915	0.000005	0.664
	VFV Lumina	0.3468	0.000026	0.586
	VFV Lumina Control	0.3847	0	0.12
5.Exhaust NOx - Indolene	Stock Taurus	0.254	0.000002	0.058
	FFV Taurus	0.1089	0.00001	0.55
	FFV Taurus Control	0.277	0.000005	0.035
6. Exhaust NOx - M85 Fuel	FFV Taurus	0.0122	0.000026	0.729
	VFV Lumina	0.162	0.000016	0.456
7. Exhaust THC - Indolene	Stock Lumina	0.257	0.000006	0.33
	VFV Lumina	0.226	0.000004	0.107
	VFV Lumina Control	0.179	0.000001	0.309
8.Exhaust THC - Indolene	Stock Taurus	0.195	0.000001	0.124
	FFV Taurus	0.219	0.000014	0.349
	FFV Taurus Control	0.113	0.000043	0.603
9. Exhaust OMHCE - M85 Fuel	FFV Taurus	0.189	0.00001	0.383
	VFV Lumina	0.183	0	0.095
10. Exhaust CH3OH - M85 Fuel	FFV Taurus	0.0149	0	0.158
	VFV Lumina	0.194	0	0.384
11. Exhaust HCHO - M85 Fuel	FFV Taurus	0.298	0.00001	0.222
	VFV Lumina	0.01846	0	0.233

Table A.5-2
Regression Parameters and Goodness of Fit
Correlation of HWFET Emission Gas Concentrations to Vehicle Mileage

Figure No.	Line	Constant	Slope	R Squared
12. HWFET Exhaust CO - Indolene	Stock Lumina	-0.434	0.00006	0.601
	VFV Lumina	0.695	0	0.055
	VFV Lumina Control	0.428	0.00001	0.611
13. HWFET Exhaust CO - Indolene	Stock Taurus	0.156	0	0.02
	FFV Taurus	-0.07	0.00007	0.924
	FFV Taurus Control	1.33	0	0.045
14. HWFET Exhaust CO - M85 Fuel	FFV Taurus	0.071	0.00002	0.433
	VFV Lumina	0.476	0.00003	0.362
15. HWFET Exhaust NOx - Indolene	Stock Lumina	0.128	0	0.008
	VFV Lumina	0.122	0.00003	0.721
	VFV Lumina Control	0.155	0	0.245
16. HWFET Exhaust NOx - Indolene	Stock Taurus	0.213	0	0.11
	FFV Taurus	0.214	0	0.07
	FFV Taurus Control	0.287	0	0.343
17. HWFET Exhaust NOx - M85 Fuel	FFV Taurus	0.025	0	0.262
	VFV Lumina	0.069	0.00001	0.621
18. HWFET Exhaust THC - Indolene	Stock Lumina			
	VFV Lumina			
	VFV Lumina Control			
19. HWFET Exhaust THC - Indolene	Stock Taurus			
	FFV Taurus			
	FFV Taurus Control			
20. HWFET Exhaust OMHCE - M85 Fuel	FFV Taurus	0.015	0	0.105
	VFV Lumina	0.008	0	0.121

Table A.5-3
Emissions and Maintenance Reported

Decal ID	Date	Odometer	Emission	FTP Cycle Weighted Results CO	NOx	THC	OMHCE	Code	Service	Comment	VIN	Lab
DC003ML	4/22/91	2389						Engine Lubricant	SM	LUBE, OIL & FILTER	2G1WL54T9M9131970	
	5/21/91	2556						Fuel Injection - Electrical Components	RPL	REPLACE #1 INJECTOR		
	5/21/91	2556						Fuel Lines and Filters (Chassis)	RPL	REPLACE FUEL FILTER		
	5/21/91	2556						Fuel Senders and Gauges	RPL	REPLACE FUEL TANK SENDING UNIT		
	5/21/91	2556						Transmission Vacuum Components	RPL	1 VACUUM LINE TO THROTTLE BODY TO VACUUM LINE ON TRANSMISSION		
	8/5/91	4527						Fuel Injection - Electrical Components	RPL	REPLACE ALL INJECTORS		
	9/26/91	6241						Electric Fuel Pumps	RPL	INSTALL UPDATED FUEL PUMP SPEED CONTROLLER		
	9/26/91	6241						Fuel Injection - Electrical Components	RPL	RETROFIT PER TSB 91-411-6E		
	2/28/92	10507						Fuel Tanks and Reservoirs	R&R	REMOVE/REINSTALL FUEL TANK TO REPLACE FUEL PUMP PULSATOR & FUEL TANK STRAINER		
	2/28/92	10507						Fuel Injection - Electrical Components	RPL	REPLACE DEFECTIVE #2 INJECTOR		
	5/12/92	12338	INDOLENE	2.4773	0.898	0.2627						ERD
	5/13/92	12378	INDOLENE	2.1383	0.9118	0.2463						ERD
	5/15/92	12429	M85	3.2167	0.5816	0.0572	0.156					ERD
	5/16/92	12469	M85	2.9915	0.556	0.0451	0.1573					ERD
	5/12/93	23604	INDOLENE	3.9841	0.8928	0.3198						ERD
	5/13/93	23646	INDOLENE	2.9299	0.8611	0.2928						ERD
	5/14/93	23686	M85	5.128	0.515	0.0885	0.2411					ERD
	5/17/93	23727	M85	4.331	0.512	0.0534	0.2273					ERD
	6/29/93	24764						Fuel Senders and Gauges	RPL	REPLACE SENDER/PUMP ASSEMBLY		
	6/29/93	24764						Front Drum Brake Assembly and Attaching Parts	RPL	REPL FRONT PADS & REFACE ROTORS		
DC006ML	5/15/91	1571						Fuel Injection - Electrical Components	R&R	REMOVE & REINSTALL PLENUM TO REPLACE #1 INJECTOR & REASSEMBLE	2G1WL54TXM9130696	
	8/4/91	1939						Fuel Injection - Electrical Components	R&R	REMOVE & REINSTALL PLENUM TO REPLACE INJECTORS		
	9/27/91	2565						Fuel Injection - Electrical Components	RPL	RETROFIT PER TBS 91-411-6E		
	9/27/91	2565						Electric Fuel Pumps	RPL	INSTALL NEW FUEL PUMP SPEED CONTROLLER		
	4/21/92	4600	INDOLENE	2.8949	0.6347	0.2858	0.2865					MANT
	4/23/92	4600	M85	2.204	0.3609	0.1134	0.2555					MANT
	7/8/92	5137						Fuel Tanks and Reservoirs	R&R	REMOVE & REINSTALL FUEL TANK TO REPLACE PULSATOR		
DC007ML	2/26/91	187						Fuel Injection - Mechanical Components	RPR	REPAIR VACUUM LEAK TO PRESSURE FUEL REGULATOR	2G1WL54T5M9131822	
	9/11/91	7179						Electric Fuel Pumps	RPL	REPLACE FUEL PUMP SPEED CONTROLLER PER REQUEST OF A/C DELCO.		
	9/27/91	7845						Fuel Injection - Electrical Components	RPL	RETROFIT PER TBS 91-411-6E		
	2/13/92	12000	INDOLENE	3.043	0.5504	0.2448	0.2448					MANT
	2/20/92	12000	M85	5.4078	0.2382	0.1401	0.2788					MANT
	3/17/92	12000	M85	4.7173	0.2282	0.1557	0.3017					MANT
DC008MLC	9/27/91	3942						Electric Fuel Pumps	RPL	REPLACE FUEL PUMP SPEED CONTROLLER	2G1WL54TXM9130262	
	9/27/91	3942						Fuel Injection - Electrical Components	RPL	RETROFIT PER TBS 91-411-6E		
	1/20/92	4452						Fuel Injection - Electrical Components	RPL	REPLACE #4 & 5 INJECTORS		
	3/11/92	4715	INDOLENE	1.4467	0.3315	0.1878						ERD
	3/11/92	4715	INDOLENE	1.4467	0.3315	0.1878						ERD
	3/12/92	4755	INDOLENE	1.5756	0.337	0.1805						ERD
	4/1/93	8198	INDOLENE	2.46	0.45	0.19						ERD
	4/2/93	8239	INDOLENE	2.239	0.48	0.17						ERD
	4/5/93	8278	M-85	3.112	0.35	0.14	0.176					ERD
	4/6/93	8319	M-85	1.969	0.38	0.11	0.148					ERD
DC011MT	4/9/91	48						Electronic Engine Control Subsystem	TST	EEC TEST	1FACP50U9MA151448	
	4/9/91	48						Exhaust Gas Recirculation	RPL	REPLACE PFE SENSOR		
	6/26/91	1589						Front End and Engine Compartment Wiring	RPL	REPLACE METHANOL HARNESS		
	6/26/91	1589						Engine Emission Control - Alternative Fuels	RPL	REPLACE PROCESSOR		
	11/14/91	3265						Fuel Tanks and Reservoirs	R&R	REPAIR/REPLACE FUEL TANK		
	11/14/91	3265						Fuel Lines and Filters (Chassis)	RPL	REPLACE FUEL FILTER		
	11/14/91	3265						Fuel Senders and Gauges	RPL	REPLACE SENDER		
	12/13/91	3415						Electronic Engine Control Subsystem	TST	EEC TEST		
	12/13/91	3415						Fuel Injection - Electrical Components	RPL	REPLACE ALL INJECTORS		
	2/29/92	4257	INDOLENE	2.5058	0.131	0.2396						ERD
	3/2/92	4295	INDOLENE	2.9655	0.1266	0.274						ERD
	3/3/92	4333	M85	2.8152	0.1213	0.0891	0.2575					ERD
	3/4/92	4372	M85	2.4821	0.1398	0.0437	0.2171					ERD
	9/10/92	6751						Sensors/Signal Conditioning Devices	RPL	REPLACE HEGO SENSOR		
	9/10/92	6751						Electronic Engine Control Subsystem	TST	EEC-IV TEST		
	9/10/92	6751						Front End and Engine Compartment Wiring	TST	PINPOINT TEST		
	12/21/92	8720						Fuel Tanks and Reservoirs	R&R	R&R FUEL TANK		
	12/21/92	8720						Front End and Engine Compartment Wiring	TST	PINPOINT TEST		
	12/21/92	8720						Electronic Engine Control Subsystem	TST	EEC TEST		
	12/21/92	8720						Electric Fuel Pumps	RPL	REPLACE FUEL PUMP		
	3/9/93	9533	INDOLENE	5.1417	0.2677	0.3095						ERD
	3/10/93	9572	INDOLENE	5.4603	0.2189	0.3012						ERD
	3/15/93	9610	M85	3.411	0.215	0.1008	0.2231					ERD
	3/16/93	9649	M85	4.175	0.217	0.0834	0.2485					ERD
	4/2/93	9843						Electrical Wiring and Circuit Protection Subsystem	TST	CHECK ELECTRICAL		
	4/2/93	9843						Electronic Engine Control Subsystem	TST	EEC TEST		

Table A.5-3
Emissions and Maintenance Reported

Decal ID	Date	Odometer	Emission	FTP Cycle Weighted Results CO	NOx	THC	OMHCE	Code	Service	Comment	VIN	Lab
	4/2/93	9843						Sensors/Signal Conditioning Devices	RPL	REPLACE MASS AIR FLOW		
	4/2/93	9843						Front End and Engine Compartment Wiring	TST	PINPOINT TEST		
	4/2/93	9843						Generator/Alternator	R&R	OVERHAUL ATLERNATOR		
DC014MT	4/22/91	404						Sensors/Signal Conditioning Devices	RPL	REPLACE MASS AIR FLOW SENSOR	1FACP50U0MA151449	
	5/6/91	729						Sensors/Signal Conditioning Devices	RPL	REPLACE MASS AIR FLOW SENSOR		
	6/7/91	1539						Electronic Engine Control Subsystem	TST	EEC TEST		
	6/7/91	1539						Engine Emission Control - Alternative Fuels	RPL	REPLACE PROCESSOR		
	7/23/91	2336						Front End and Engine Compartment Wiring	RPL	REPLACE METHANOL WIRING HARNESS		
	7/23/91	2336						Electronic Engine Control Subsystem	TST	EEC TEST		
	7/23/91	2336						Engine Emission Control - Alternative Fuels	RPL	REPLACE PROCESSOR		
	7/23/91	2336						Fuel Injection - Electrical Components	RPL	REPLACE INJECTORS		
	7/23/91	2336						Electric Fuel Pumps	RPL	REPLACE PUMP		
	7/23/91	2336						Fuel Senders and Gauges	RPL	REPLACE FUEL SENDING UNIT		
	1/29/92	6204						Electric Fuel Pumps	RPL	REPLACE PUMP		
	1/29/92	6204						Fuel Tank and Lines Subsystem	TST	TEST SENSOR EYE		
	1/29/92	6204						Fuel Tanks and Reservoirs	R&R	REPAIR/REPLACE FUEL TANK		
	1/29/92	6204						Fuel	TST	TEST FUEL SAMPLE		
	1/29/92	6204						Electronic Engine Control Subsystem	TST	EEC TEST		
	1/29/92	6204						Electronic Engine Control Subsystem	RPR	REPAIR HOSE TO MASS AIR FLOW SENSOR		
	2/26/92	7127						Electronic Engine Control Subsystem	TST	EEC TEST		
	2/26/92	7127						Intake Manifold	R&R	REPAIR/REPLACE PLENEUM CHAMBER		
	2/26/92	7127						Electric Fuel Pumps	TST	PRESSURE TEST		
	2/26/92	7127						Computer Assembly	TST	SBDS FUEL FLOW TEST		
	9/18/92	14060						Electric Fuel Pumps	RPL	REPLACE FUEL PUMP SWITCH		
	9/18/92	14060						Electric Fuel Pumps	RPL	REPLACE INTEGRATE CONTROL MODULE		
	9/17/92	14100	INDOLENE	5.0467	0.2665	0.3671	0.3671					MANT
	9/16/92	14100	M85	5.0283	0.551	0.1468	0.3328					MANT
	2/9/93	16180						Fuel Lines and Filters (Chassis)	RPL	REPLACE FUEL FILTER		
	2/9/93	16180						Front End and Engine Compartment Wiring	TST	PINPOINT TEST		
	2/9/93	16180						Fuel Lines and Filters (Chassis)	RPL	REPLACE FUEL FILTER		
	2/9/93	16180						Electronic Engine Control Subsystem	TST	EEC TEST		
	2/9/93	16180						Battery	RPR	TRACE & REPAIR OPEN PK/BK WIRE UNDER BATTERY (BURNT)		
	2/9/93	16180						Front End and Engine Compartment Wiring	TST	PINPOINT TEST		
	2/9/93	16180						Electronic Engine Control Subsystem	TST	EEC TEST		
	2/9/93	16180						Multiple Function Electronic Modules	TST	CHECK MULTIFUNTION RELAYS		
DC016MT	6/21/91	365						Electrical Wiring and Circuit Protection Subsystem	RPL	REPLACE WIRES-EVIDENTLY RODENT EATEN	1FACP50U6MA151455	
	7/8/91	578						Front End and Engine Compartment Wiring	RPL	REPLACE EEC METHANOL WIRING HARNESS		
	7/8/91	578						Engine Emission Control - Alternative Fuels	RPL	REPLACE PROCESSOR		
	7/8/91	578						Fuel Injection - Mechanical Components	RPL	REPLACE FUEL PRESSURE REG		
	7/8/91	578						Fuel Senders and Gauges	RPL	REPLACE SENDING UNIT		
	7/8/91	578						Electronic Engine Control Subsystem	TST	EEC TEST		
	9/16/91	1283						Front End and Engine Compartment Wiring	ADJ	SECURE HARNESS		
	10/15/91	2234						Electronic Engine Control Subsystem	TST	EEC TEST		
	10/15/91	2234						Computer Assembly	TST	SBDS TEST		
	10/15/91	2234						Fuel Injection - Electrical Components	TST	TEST FUEL INJECTOR OUTPUT & HOLDING PRESSURE		
	10/15/91	2234						Sensors/Signal Conditioning Devices	RPL	REPLACE MASS SENSOR		
	10/25/91	2459						Electronic Engine Control Subsystem	TST	EEC TEST		
	10/25/91	2459						Electric Fuel Pumps	TST	TEST FUEL PRESSURE		
	11/12/91	2682						Electronic Engine Control Subsystem	TST	EEC TEST		
	11/12/91	2682						Electric Fuel Pumps	TST	PRESSURE TEST FUEL SYSTEM		
	11/12/91	2682						Sensors/Signal Conditioning Devices	RPL	REPLACE MASS AIR FLOW SENSOR		
	12/9/91	3616						Electronic Engine Control Subsystem	TST	EEC TEST		
	12/9/91	3616						Front End and Engine Compartment Wiring	RPL	REPAIR/REPLACE EEC HARNESS		
	12/9/91	3616						Sensors/Signal Conditioning Devices	RPL	REPLACE MASS AIR FLOW SENSOR		
	3/3/92	6334						Electronic Engine Control Subsystem	TST	EEC TEST		
	3/3/92	6334						Fuel	TST	TEST METHANOL CONTENT		
	3/3/92	6334						Engine Emission Control - Alternative Fuels	RPL	REPLACE PROCESSOR		
	3/3/92	6334						Electric Fuel Pumps	TST	TEST FUEL PRESSURE		
	3/3/92	6334						Front End and Engine Compartment Wiring	RPL	REPLACE METHANOL HARNESS		
	7/21/92	10600	INDOLENE	6.4692	0.2122	0.6086	0.6086					MANT
	7/23/92	10600	M85	4.33	0.1966	0.1985	0.463					MANT
	9/30/92	11394						Electronic Engine Control Subsystem	TST	EEC TEST		
	9/30/92	11394						Electric Fuel Pumps	TST	FUEL PRESSURE TEST		
	9/30/92	11394						Fuel Senders and Gauges	RPL	REPLACE FUEL TANK UNIT		
	10/23/92	12036						Front End and Engine Compartment Wiring	TST	PINPOINT TEST		
	10/23/92	12036						Electric Fuel Pumps	RPL	REPLACE FUEL PUMP		
	10/23/92	12036						Electronic Engine Control Subsystem	TST	EEC TEST		
	10/23/92	12036						Fuel Lines and Filters (Chassis)	RPL	REPLACE FUEL FILTER		
	10/23/92	12036						Front End and Engine Compartment Wiring	TST	PINPOINT TEST		

Table A.5-3
Emissions and Maintenance Reported

Decal ID	Date	Odometer	Emission	FTP Cycle Weighted Results CO	NOx	THC	OMHCE	Code	Service	Comment	VIN	Lab
	10/23/92	12036						Electronic Engine Control Subsystem	TST	EEC TEST		
	3/21/93	14593						Electronic Engine Control Subsystem	TST	EEC TEST		
	3/21/93	14593						Fuel Injection - Electrical Components	RPL	REPLACE INJECTORS		
	3/21/93	14593						Intake Manifold	R&R	R & R PLENEUM FOR ACCESS		
	3/21/93	14593						Fuel	TST	PINPOINT TEST		
DC023MTC	5/6/91	870						Electronic Engine Control Subsystem	TST	EEC TEST	1FACP50U5MA151446	
	5/6/91	870						Front End and Engine Compartment Wiring	RPR	TRACE & REPAIR LOOSE CONNECTION IN EEC HARNESS		
	5/6/91	870						Sensors/Signal Conditioning Devices	RPL	REPLACE AIR MASS		
	5/6/91	870						Front End and Engine Compartment Wiring	RPR	TRACE & REPAIR LOOSE CONNECTION IN HARNESS		
	8/14/91	3505						Electronic Engine Control Subsystem	TST	EEC TEST		
	8/14/91	3505						Engine Emission Control - Alternative Fuels	RPL	REPLACE PROCESSOR		
	8/14/91	3505						Fuel Senders and Gauges	RPL	REPLACE FUEL SENDING UNIT		
	8/14/91	3505						Fuel Injection - Mechanical Components	RPL	REPLACE FUEL PRESS REG		
	8/14/91	3505						Front End and Engine Compartment Wiring	RPL	REPLACE EEC METH WIRING HARNESS		
	10/16/91	4046						Engine Mounts	R&R	REPL/REPAIR MOTOR MOUNT, RETAP THREADS, REPL BOLT & RESECURE		
	3/20/92	6710	INDOLENE	5.4208	0.419	0.3961						ERD
	3/23/92	6748	INDOLENE	4.9931	0.4907	0.3579						ERD
	4/13/92	7077						Electronic Engine Control Subsystem	TST	EEC TEST		
	4/13/92	7077						Sensors/Signal Conditioning Devices	RPR	REPAIR OPEN IN WIRE TO MASS AIR FLOW SENSOR		
	7/27/92	9114						Electronic Engine Control Subsystem	TST	EEC TEST		
DC025GTC	2/20/92	6839	INDOLENE	2.6065	0.2281	0.2295					1FACP50U4MA206078	ERD
	2/21/92	6877	INDOLENE	2.4039	0.2476	0.2195						ERD
	6/23/92	9600	INDOLENE	4.1537	0.4743	0.293	0.293					MANT
	1/23/93	12703	INDOLENE	2.0544	0.2307	0.189						ERD
	1/24/93	12742	INDOLENE	2.376	0.2548	0.2196						ERD
DC026GLC	2/26/92	4776	INDOLENE	1.5657	0.3014	0.2269					2G1WL54T2M9197308	ERD
	2/27/92	4816	INDOLENE	1.213	0.2912	0.1976						ERD
	11/10/92	15300	INDOLENE	10.7568	0.436	0.5866	0.5866					MANT
	9/1/92	15343						Automatic Transmission/Transaxle Subsystem	R&R	REMOVE AND RECONDITION TRANSAXLE		
DT003ML	12/18/90	23						Camshaft and Drive	TST	CAMS CHECK	2G1WL54T8M9130843	
	12/18/90	23						Wiring, Connector, Terminal, Socket, Relay, and Module Fa	RPR	REPAIR LOOSE CONNECTOR TO IAC VALVE		
	12/3/91	5076	M85	1.51	0.299	0.082	0.187					EPA1
	12/4/91	5141	INDOLENE	0.9121	0.4273	0.193						EPA1
	6/16/92	11063	INDOLENE	2.5983	0.5956	0.2562						EPA1
	6/17/92	11096	INDOLENE	1.676	0.5805	0.1967						EPA1
	6/18/92	11140	M85	2.3878	0.3282	0.084	0.203					EPA1
	6/19/92	11173	M85	1.8785	0.3502	0.063	0.172					EPA1
	6/23/92	11221	M50	0.9268	0.3976	0.105	0.136					EPA1
	6/24/92	11254	M50	1.282	0.5179	0.136	0.18					EPA1
DT004ML	7/31/91	1610	M85	2.761	0.055	0.069	0.164				2G1WL54T3M9130622	EPA1
	8/1/91	1668	INDOLENE	2.223	0.125	0.183						EPA1
	1/16/92	4873	INDOLENE	1.6323	0.4384	0.21						EPA1
	1/17/92	4921	M85	2.893	0.193	0.088	0.158					EPA1
	5/18/93	11127	M85	1.53	0.29	0.161						EPA1
	5/5/93	11137.6	INDOLENE	1.28	0.76	0.514						EPA1
	5/6/93	11178.2	INDOLENE	1.31	0.69	0.404						EPA1
	5/12/93	11284.1	M50	1.28	0.4	0.308						EPA1
	5/13/93	11324.8	M50	1.06	0.48	0.339						EPA1
	5/20/93	11418.3	M85	3.75	0.28	0.173						EPA1
DT005MLC	10/11/91	8597	INDOLENE	2.6177	0.2035	0.215					2G1WL54T9M9130981	EPA1
	9/17/92	19793	INDOLENE	2.617	0.29	0.195						EPA1
	9/18/92	19841	INDOLENE	2.1492	0.2613	0.21878						EPA1
DT006MT	6/7/91	163	M85	1.786	0.077	0.077	0.221				1FACP50U3MA151459	EPA1
	6/11/91	212	M85	1.877	0.067	0.065	0.226					EPA1
	7/11/91	261	INDOLENE	3.053	0.148	0.292						EPA1
	7/12/91	291	INDOLENE	2.51	0.155	0.245						EPA1
	3/25/92	3293	M85	1.993	0.084	0.066	0.186					EPA1
	3/26/92	3336	INDOLENE	2.6444	0.1596	0.2351						EPA1
	12/8/92	8513						Electronic Engine Control Subsystem	TST	EEC TEST		
	12/8/92	8513						Fuel Injection - Electrical Components	RPL	REPLACE FUEL INJECTORS		
	4/20/93	8520						Front End and Engine Compartment Wiring	TST	PINPOINT TEST		
	4/20/93	8520						Fuel Charging and Controls Subsystem	RPL	FORD FFV UPDATE KIT INSTALLED		
	4/20/93	8520						Electronic Engine Control Subsystem	TST	EEC IV TEST		
DT007MT	10/14/91	2337						Air Cleaner and Associated Components	RPL	REPLACE AIR CLEANER ASY	1FACP50U5MA151463	
	10/14/91	2337						Instrument Panel and Cowl Wiring	R&R	INSTRMENT PANL ACCES		
	10/14/91	2337						Instrument Cluster/Console Modules	RPR	INSTR CLUSTR R/I STD		
	10/14/91	2337						Electrical Wiring and Circuit Protection Subsystem	R&R	REPAIR/REPLACE MAIN WIRING ASY		
	10/16/91	2337						Electric Fuel Pumps	TST	FUEL PUMP TEST		

Table A.5-3
Emissions and Maintenance Reported

Decal ID	Date	Odometer	Emission	FTP Cycle Weighted Results CO	NOx	THC	OMHCE	Code	Service	Comment	VIN	Lab
	10/16/91	2337						Body Dash and Cowl	RPL	REPLACE COWL GRILL		
	10/16/91	2337						Electric Fuel Pumps	RPL	REPLACE FUEL PUMP		
	3/27/92	4182	M85	1.923	0.064	0.07	0.189					EPA1
	3/31/92	4226	INDOLENE	2.4428	0.0535	0.2035						EPA1
	4/20/93	9943						Fuel Injection - Electrical Components	RPL	REPLACE INJECTORS		
	4/20/93	9943						Electric Fuel Pumps	TST	FUEL PUMP TEST		
	4/20/93	9943						Electronic Engine Control Subsystem	TST	EEC IV TEST		
DT020MTC	6/14/91	2087						Electronic Engine Control Subsystem	TST	EEC DIAG	1FACP50U3MA151462	
	6/14/91	2087						Engine Emission Control - Alternative Fuels	RPL	REPLACE PROCESSOR		
	8/14/91	3458	INDOLENE	3.0975	0.0907	0.312						EPA1
	10/1/91	4017						Engine Emission Control - Alternative Fuels	RPL	REPLACE PROCESSOR		
	10/1/91	4017						Fuel Injection - Mechanical Components	RPL	REPLACE REGULATOR		
	10/1/91	4017						Electronic Engine Control Subsystem	TST	EEC DIAG TST		
	10/1/91	4017						Electric Fuel Pumps	RPL	REPLACE FUEL PUMP		
	3/24/92	15703	INDOLENE	3.2785	0.166	0.4433						EPA1
	4/17/92	15766	INDOLENE	7.6558	0.4308	1.006						EPA1
	4/20/92	15797						Electronic Engine Control Subsystem	TST	EEC IV-DIAG(QUIK TST)		
	4/20/92	15797						Front End and Engine Compartment Wiring	TST	PINPOINT TEST		
	4/20/92	15797						Engine Emission Control - Alternative Fuels	RPL	REPLACE PROCESSOR ASSEMBLY, REPAIR WIRING		
	4/29/92	15805	INDOLENE	7.3331	0.4167	0.9725						EPA1
	12/2/92	23586						Electronic Engine Control Subsystem	TST	EEC QUIK TEST		
	12/2/92	23586						Fuel Injection - Electrical Components	RPL	REPLACE INJECTORS		
DT022GLC	10/23/91	8066	INDOLENE	2.3998	0.3209	0.272					2G1WL54T4M9196449	EPA1
	3/20/92	15905	INDOLENE	6.8002	0.4384	0.3824						EPA1
	3/27/92	15964						Camshaft and Drive	TST	CAMS TEST		
	3/27/92	15964						Front End and Engine Compartment Wiring	RPR	REPAIR OPEN IN CIRCUIT 412 TO OXYGEN SENSOR		
	4/1/92	15973	INDOLENE	4.7658	0.3627	0.3898						EPA1
	4/3/92	16013						Camshaft and Drive	TST	CAMS TEST		
	4/3/92	16013						Control Modules and Solenoids	RPL	REPLACE EVAP SOLENOID/SENSOR		
	4/10/92	16013						Fuel Injection - Electrical Components	TST	BALANCE TEST & LEAK TEST INJECTORS		
	4/10/92	16013						Engine Coolant Heating Element	RPL	REPLACE THERMOSTAT		
	4/10/92	16013						Sensors/Signal Conditioning Devices	RPL	REPLACE OXYGEN SENSOR		
	4/10/92	16013						Exhaust Manifold	TST	INSPECT FOR EXHAUST LEAKS AROUND MANIFOLD & SENSOR AREAS		
	2/19/93	32444.5	INDOLENE	6.4	0.48	0.397						EPA1
	3/31/93	32489	INDOLENE	7.16	0.52	0.521						EPA1
	4/27/93	32533.8	INDOLENE	2.75	0.39	0.357						EPA1
DT023GTC	10/16/91	2002	INDOLENE	2.0036	0.263	0.153					1FACP50UXMG192961	EPA1
	9/29/92	14885	INDOLENE	2.3375	0.2342	0.20778						EPA1
	10/1/92	14930	INDOLENE	2.1475	0.2791	0.19319						EPA1
	4/1/93	23992	INDOLENE	2.88	0.36	0.238						EPA1
	4/2/93	24023	INDOLENE	3.16	0.31	0.246						EPA1

		Table A.5-4								
		Emissions FTP Test Results Used in this Analysis								
DECAL_ID	TEST_DATE	ODOMETER	LAB	FUEL	CO	NOx	THC	CH3OH	HCHO	OMHCE
					g/mi	g/mi	g/mi	g/mi	g/mi	g/mi
DECAL_ID	TEST_DATE	ODOMETER	LAB	FUEL	CO	NOx	THC	CH3OH	HCHO	OMHCE
					g/mi	g/mi	g/mi	g/mi	g/mi	g/mi
DC003ML	5/12/92	12338	ERD	INDOLENE	2.4773	0.898	0.2627		0.00514	
DC003ML	5/13/92	12378	ERD	INDOLENE	2.1383	0.9118	0.2463		0.00573	
DC003ML	5/12/93	23604	ERD	INDOLENE	3.9841	0.8928	0.3198		0.0061395	
DC003ML	5/13/93	23646	ERD	INDOLENE	2.9299	0.8611	0.2928		0.0062252	
DC006ML	4/21/92	4600	MANT	INDOLENE	2.8949	0.6347	0.2858			0.2865
DC007ML	2/13/92	12000	MANT	INDOLENE	3.043	0.5504	0.2448			0.2448
DC008MLC	3/11/92	4715	ERD	INDOLENE	1.4467	0.3315	0.1878		0.0034619	
DC008MLC	3/11/92	4715	ERD	INDOLENE	1.4467	0.3315	0.1878		0.00346	
DC008MLC	3/12/92	4755	ERD	INDOLENE	1.5756	0.337	0.1805		0.00444	
DC008MLC	4/1/93	8198	ERD	INDOLENE	2.46	0.45	0.19		0.004661	
DC008MLC	4/2/93	8239	ERD	INDOLENE	2.239	0.48	0.17		0.004946	
DC011MT	2/29/92	4257	ERD	INDOLENE	2.5058	0.131	0.2396		0.00569	
DC011MT	3/2/92	4295	ERD	INDOLENE	2.9655	0.1266	0.274		0.00383	
DC011MT	3/9/93	9533	ERD	INDOLENE	5.1417	0.2677	0.3095		0.0025235	
DC011MT	3/10/93	9572	ERD	INDOLENE	5.4603	0.2189	0.3012		0.0025258	
DC014MT	9/17/92	14100	MANT	INDOLENE	5.0467	0.2665	0.3671			0.3671
DC016MT	7/21/92	10600	MANT	INDOLENE	6.4692	0.2122	0.6086			0.6086
DC023MTC	3/20/92	6710	ERD	INDOLENE	5.4208	0.419	0.3961		0.00438	
DC023MTC	3/23/92	6748	ERD	INDOLENE	4.9931	0.4907	0.3579		0.0045	
DC025GTC	2/20/92	6839	ERD	INDOLENE	2.6065	0.2281	0.2295		0.00225	
DC025GTC	2/21/92	6877	ERD	INDOLENE	2.4039	0.2476	0.2195		0.00284	
DC025GTC	6/23/92	9600	MANT	INDOLENE	4.1537	0.4743	0.293			0.293
DC025GTC	1/23/93	12703	ERD	INDOLENE	2.0544	0.2307	0.189		0.0022297	
DC025GTC	1/24/93	12742	ERD	INDOLENE	2.376	0.2548	0.2196		0.0027	
DC026GLC	2/26/92	4776	ERD	INDOLENE	1.5657	0.3014	0.2269		0.00704	
DC026GLC	2/27/92	4816	ERD	INDOLENE	1.213	0.2912	0.1976		0.00668	
DC026GLC	11/10/92	15300	MANT	INDOLENE	10.7568	0.436	0.5866			0.5866
DT003ML	12/4/91	5141	EPA1	INDOLENE	0.9121	0.4273	0.193			
DT003ML	6/16/92	11063	EPA1	INDOLENE	2.5983	0.5956	0.2562			
DT003ML	6/17/92	11096	EPA1	INDOLENE	1.676	0.5805	0.1967			
DT004ML	8/1/91	1668	EPA1	INDOLENE	2.223	0.125	0.183			
DT004ML	1/16/92	4873	EPA1	INDOLENE	1.6323	0.4384	0.21			
DT004ML	5/5/93	11137.6	EPA1	INDOLENE	1.28	0.76	0.514			
DT004ML	5/6/93	11178.2	EPA1	INDOLENE	1.31	0.69	0.404			
DT005MLC	10/11/91	8597	EPA1	INDOLENE	2.6177	0.2035	0.215			
DT005MLC	9/17/92	19793	EPA1	INDOLENE	2.617	0.29	0.195			
DT005MLC	9/18/92	19841	EPA1	INDOLENE	2.1492	0.2613	0.21878			
DT006MT	7/11/91	261	EPA1	INDOLENE	3.053	0.148	0.292			
DT006MT	7/12/91	291	EPA1	INDOLENE	2.51	0.155	0.245			
DT006MT	3/26/92	3336	EPA1	INDOLENE	2.6444	0.1596	0.2351			
DT007MT	3/31/92	4226	EPA1	INDOLENE	2.4428	0.0535	0.2035			
DT020MTC	8/14/91	3458	EPA1	INDOLENE	3.0975	0.0907	0.312			
DT020MTC	3/24/92	15703	EPA1	INDOLENE	3.2785	0.166	0.4433			
DT020MTC	4/17/92	15766	EPA1	INDOLENE	7.6558	0.4308	1.006			
DT020MTC	4/29/92	15805	EPA1	INDOLENE	7.3331	0.4167	0.9725			
DT022GLC	10/23/91	8066	EPA1	INDOLENE	2.3998	0.3209	0.272			
DT022GLC	3/20/92	15905	EPA1	INDOLENE	6.8002	0.4384	0.3824			
DT022GLC	4/1/92	15973	EPA1	INDOLENE	4.7658	0.3627	0.3898			
DT022GLC	2/19/93	32444.5	EPA1	INDOLENE	6.4	0.48	0.397			
DT022GLC	3/31/93	32489	EPA1	INDOLENE	7.16	0.52	0.521			
DT022GLC	4/27/93	32533.8	EPA1	INDOLENE	2.75	0.39	0.357			
DT023GTC	10/16/91	2002	EPA1	INDOLENE	2.0036	0.263	0.153			
DT023GTC	9/29/92	14885	EPA1	INDOLENE	2.3375	0.2342	0.20778			
DT023GTC	10/1/92	14930	EPA1	INDOLENE	2.1475	0.2791	0.19319			

			Table A.5-4							
		Emissions FTP Test Results Used in this Analysis								
DECAL_ID	TEST_DATE	ODOMETER	LAB	FUEL	CO	NOx	THC	CH3OH	HCHO	OMHCE
					g/mi	g/mi	g/mi	g/mi	g/mi	g/mi
DT023GTC	4/1/93	23992	EPA1	INDOLENE	2.88	0.36	0.238			
DT023GTC	4/2/93	24023	EPA1	INDOLENE	3.16	0.31	0.246			
DC008MLC	4/5/93	8278	ERD	M85	3.112	0.35	0.14	0.221	0.017637	0.176
DC008MLC	4/6/93	8319	ERD	M85	1.969	0.38	0.11	0.223	0.021294	0.148
DC003ML	5/15/92	12429	ERD	M85	3.2167	0.5816	0.0572	0.2062	0.02192	0.156
DC003ML	5/16/92	12469	ERD	M85	2.9915	0.556	0.0451	0.234	0.0252	0.1573
DC003ML	5/14/93	23686	ERD	M85	5.128	0.515	0.0885	0.3304	0.0219164	0.2411
DC003ML	5/17/93	23727	ERD	M85	4.331	0.512	0.0534	0.3737	0.0278552	0.2273
DC006ML	4/23/92	4600	MANT	M85	2.204	0.3609	0.1134	0.328		0.2555
DC007ML	2/20/92	12000	MANT	M85	5.4078	0.2382	0.1401	0.3202		0.2788
DC007ML	3/17/92	12000	MANT	M85	4.7173	0.2282	0.1557	0.3368		0.3017
DC011MT	3/3/92	4333	ERD	M85	2.8152	0.1213	0.0891	0.3687	0.02012	0.2575
DC011MT	3/4/92	4372	ERD	M85	2.4821	0.1398	0.0437	0.3792	0.02128	0.2171
DC011MT	3/15/93	9610	ERD	M85	3.411	0.215	0.1008	0.268	0.0144398	0.2231
DC011MT	3/16/93	9649	ERD	M85	4.175	0.217	0.0834	0.3611	0.0199689	0.2485
DC014MT	9/16/92	14100	MANT	M85	5.0283	0.551	0.1468	0.4297		0.3328
DC016MT	7/23/92	10600	MANT	M85	4.33	0.1966	0.1985	0.6109		0.463
DT003ML	12/3/91	5076	EPA1	M85	1.51	0.299	0.082	0.212	0.0271	0.187
DT003ML	6/18/92	11140	EPA1	M85	2.3878	0.3282	0.084	0.249	0.02442	0.203
DT003ML	6/19/92	11173	EPA1	M85	1.8785	0.3502	0.063	0.226	0.02423	0.172
DT004ML	7/31/91	1610	EPA1	M85	2.761	0.055	0.069	0.202	0.01693	0.164
DT004ML	1/17/92	4921	EPA1	M85	2.893	0.193	0.088	0.147	0.01322	0.158
DT004ML	5/18/93	11127	EPA1	M85	1.53	0.29	0.161			
DT004ML	5/20/93	11418.3	EPA1	M85	3.75	0.28	0.173			
DT006MT	6/7/91	163	EPA1	M85	1.786	0.077	0.077	0.317	0.01414	0.221
DT006MT	6/11/91	212	EPA1	M85	1.877	0.067	0.065	0.355	0.01326	0.226
DT006MT	3/25/92	3293	EPA1	M85	1.993	0.084	0.066	0.263	0.01447	0.186
DT007MT	3/27/92	4182	EPA1	M85	1.923	0.064	0.07	0.26	0.01429	0.189

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		Table A.5-5							
	Emissions Highway Cycle Test Results Used in this Analysis								
Decal ID	Test Date	Odometer	Lab	Fuel	MPG	CO, g/mi	NOx, g/mi	THC, g/mi	OMHCE, g/mi
Decal ID	Test Date	Odometer	Lab	Fuel	MPG	CO, g/mi	NOx, g/mi	THC, g/mi	OMHCE, g/mi
DT022GLC	10/23/91	8078	EPA1	INDOLENE	34.3	0.295	0.144	0.027	
DT022GLC	3/20/92	15917	EPA1	INDOLENE	34.1	0.486	0.147	0.023	
DT022GLC	4/1/92	15985	EPA1	INDOLENE	33.6	0.365	0.093	0.023	
DT022GLC	2/19/93	32464.5	EPA1	INDOLENE	30	1.994	0.136	0.53	
DT022GLC	3/31/93	32500	EPA1	INDOLENE	29.6	2.296	0.126	0.085	
DT022GLC	4/27/93	32553.8	EPA1	INDOLENE	28.9	0.74	0.146	0.046	
DC025GTC	2/20/92	6850	ERD	INDOLENE	35.63	0.17906	0.17541	0.02382	
DC025GTC	2/21/92	6888	ERD	INDOLENE	35.68	0.1775	0.21568	0.02268	
DC026GLC	2/26/92	4787	ERD	INDOLENE	34.22	0.36427	0.12936	0.02946	
DC026GLC	2/27/92	4827	ERD	INDOLENE	33.77	0.28341	0.10739	0.02322	
DT023GTC	10/16/91	2013	EPA1	INDOLENE	36.04	0.036	0.32	0.008	
DT023GTC	9/29/92	14896	EPA1	INDOLENE	39.2	0.166	0.072	0.021	
DT023GTC	10/1/92	14942	EPA1	INDOLENE	37.9	0.118	0.151	0.015	
DC025GTC	1/23/93	12714	ERD	INDOLENE	35.85	0.0681	0.2442	0.0239	
DC025GTC	1/24/93	12753	ERD	INDOLENE	36.14	0.0524	0.2274	0.0228	
DT023GTC	4/1/93	24013	EPA1	INDOLENE	39.8	0.191	0.133	0.018	
DT023GTC	4/2/93	24043.5	EPA1	INDOLENE	39.6	0.353	0.165	0.022	
DC003ML	5/12/92	12349	ERD	INDOLENE	34.63	0.60108	0.80492	0.03468	
DC003ML	5/13/92	12389	ERD	INDOLENE	34.76	0.62683	0.74821	0.0302	
DT003ML	12/4/91	5152	EPA1	INDOLENE	34.27	0.459	0.423	0.026	
DT003ML	6/16/92	11075	EPA1	INDOLENE	35.4	0.683	0.505	0.027	
DT003ML	6/17/92	11107	EPA1	INDOLENE	34.9	0.668	0.52	0.027	
DT004ML	7/27/91	1680	EPA1	INDOLENE	33.64	0.913	0.018	0.059	
DT004ML	1/16/92	4893	EPA1	INDOLENE	33.87	0.487	0.115	0.026	
DC003ML	5/12/93	23616	ERD	INDOLENE	35.72	0.5536	0.8321	0.0293	
DC003ML	5/13/93	23657	ERD	INDOLENE	36.14	0.6068	0.8162	0.0315	
DT004ML	5/5/93	11160.4	EPA1	INDOLENE	33.8	0.685	0.445	0.03	
DT004ML	5/6/93	11189.8	EPA1	INDOLENE	32.7	0.794	0.447	0.034	
DC008MLC	3/11/92	4726	ERD	INDOLENE	35.49	0.46495	0.16487	0.02232	
DC008MLC	3/12/92	4766	ERD	INDOLENE	35.9	0.53407	0.14052	0.01919	
DT005MLC	10/11/91	8603	EPA1	INDOLENE	35.59	0.709	0.07	0.025	
DT005MLC	9/17/92	19803	EPA1	INDOLENE	31.837	0.932	0.138	0.027	
DT005MLC	9/18/92	19853	EPA1	INDOLENE	34.3642	0.642	0.076	0.018	
DC008MLC	3/11/92	4726	ERD	INDOLENE	35.49	0.465	0.1649	0.0223	
DC011MT	2/29/92	4268	ERD	INDOLENE	35.26	0.21324	0.2064	0.04362	
DC011MT	3/2/92	4306	ERD	INDOLENE	35.68	0.22114	0.16761	0.03501	
DT006MT	7/11/91	271	EPA1	INDOLENE	32.59	0.016	0.244	0.018	
DT006MT	7/12/91	302	EPA1	INDOLENE	32.59	0.012	0.295	0.017	
DT006MT	3/26/92	3347	EPA1	INDOLENE	34	0.097	0.159	0.03	
DT007MT	3/31/92	4237	EPA1	INDOLENE	34.6	0.095	0.041	0.013	
DC011MT	3/9/93	9544	ERD	INDOLENE	35.14	0.622	0.1621	0.0337	
DC011MT	3/10/93	9572	ERD	INDOLENE	35.4	0.671	0.238	0.044	
DC023MTC	3/20/92	6721	ERD	INDOLENE	36.56	0.23083	0.27287	0.03519	
DC023MTC	3/23/92	6759	ERD	INDOLENE	36.55	0.27717	0.27073	0.03561	
DT020MTC	8/14/91	3468	EPA1	INDOLENE	33.78	2.45	0.192	0.043	
DT020MTC	3/24/92	15713	EPA1	INDOLENE	38.2	0.669	0.062	0.118	
DT020MTC	4/17/92	15766	EPA1	INDOLENE	37.8	1.347	0.21	0.203	
DC003ML	5/15/92	12440	ERD	M85	20.0845	1.20723	0.13517	0.01194	0.01816
DC003ML	5/16/92	12480	ERD	M85	19.9249	1.05484	0.47114	0.00988	0.01106
DT003ML	12/3/91	5087	EPA1	M85	20.33	0.596	0.271	0.013	0.013